Volume XII Number 8

The Philippine Agriculturist

(University of the Philippines Publications: Series A)

January, 1924

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The Philippine Agriculturist

(University of the Philippines Publications: Series A)

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The
Philippine Agriculturist

Volume XII January, 1924 No. 8

JANUARY, 1924

January, the two-faced month, is the period when we pause and look back, reflectively and inventorially, over the twelve months just completed, and forward, hopefully and perhaps adventurously, to the twelve months just ahead. This January stock-taking is a good thing for the individual, the institution, and the nation, only we are prone to use poor judgment in making valuation of the items, the events. There the difficulty lies. The events that loom large in 1923, time will show to be small. Only the sight of a seer, coupled with the wisdom of a sage, could give the events of the year just closed their proper evaluation.

It would be a fruitful study to weigh and revise in the light of present knowledge the annual published lists of notable events in any country for the past one hundred, fifty, or even twenty-five years. If, in the revision, discrimination between important and prominent events be made the revised lists would be practically new ones.

It is Huxley who comments, in speaking of the unnoted early achievements of the Royal Society, on the common and persistent error of mistaking the prominent event for the important one.

No list of outstanding events in the Philippines for 1923 has yet appeared, but it would include the usual happenings related to politics and politicians; calamities resulting from typhoons; ravages of rinderpest, anthrax, and locusts; increase of sugar output, perhaps, but not the causes—the experimental work, the better mills; conventions and parades; prominent, not always important, foreign visitors; possibly the opening of new roads, here again, the prominent, probably, and not the important, because the shorter or less heralded would not be included. The negative happenings, that is the important turned-down chance, the missed opportunity, would not be listed, of course. This is another error in our inventories.

In 2024 or 1974, in all likelihood, none of these events will have a place in Philippine history. It is reasonably certain that the year will be marked, if marked at all, by events not now recognized as worth making a note of. It may be that a first step or the completion of an invention that cannot get a hearing now, but will be of untold benefit to the farmer, the housewife, the sailor or the merchant, hence to the nation, will make the year notable. The twelve-month may be marked by an investigation, an experiment that will lead to incalculable good in crop production. Mendel and his sweet peas were not in the national or scientific inventories of 1854, and his first contribution to the Society of Natu-

ralists of Brünn is referred to as "now memorable". Some law, mayhap, that stirred no oratorical rumblings, had no space in our newspapers, may give the present Philippine Congress a place in the country's annals while the laws now regarded highly will be preserved only in mildewed records. The Filipino vaudeville which has sprung into popularity in the past year would hardly find a place in our list, yet the future history of the Philippine stage may give the year because of these unfledged efforts a place not incomparable with certain years in the evolution of the English stage.

It is difficult to see happenings with even moderate accuracy when we are so near. Our vision is blurred, we magnify the wrong object. And we are stupid, indifferent to what is going on around us unless there is a blare of horns, a glare of color to herald popularity, then we too shout "It is great! It is wonderful!"

All history of man and of nature teaches us that beginnings of important things are small, obscure; that growth is quiet. But we do not learn. We go stumblingly on our way nudging aside and too often trampling on the important because it is unobtrusive.

In our College? Its events for 1923? The new roads, the new buildings, even the new flag staff, the athletic victories, the noted visitors, the meetings— these are the prominent events; are they the important ones? Even here where Science holds sway, where Truth is not crushed to earth, where the god of things as they are is worked for— are important events distinguished from prominent ones?

Some plant of future nation-wide benefit may have been added to the College cultures. Laboratory studies, that some day will be esteemed of such importance that the year 1923 will be a notable date in Philippine history of science may have been carried out on the Campus. But these are not of public record; they are unblazoned. Some student, some faculty member may have discovered some latent talent of unusual potentiality. We may have our Darwin, our Turczaninov, our Pasteur, our Burbank. Some Filipino Huxley may one day tell of the meeting in 1923, for the first time, of the Los Baños Biological Club.

If only we could list the important not the prominent events in 1924.

EMMA S. YULE
Of the Department of English.

SECOND ADDITION TO PHILIPPINE AND MALAYAN TECHNICAL BIBLIOGRAPHY

By Charles Fuller Baker

Dean, College of Agriculture

The first installment of this bibliography of published contributions, based wholly or in part on material furnished by C. F. Baker, was published in this journal in 1919 (**8:** 32-37)[1]. The second installment appeared in the same journal in 1922 (**10:** 363-366)[2]. The present installment shows increased activity and by many additional authors[3].

This enterprise—undertaken and carried privately—has now assumed a place of first importance among exploratory undertakings and faunal studies in Pacific countries. On January 1, 1924, there were one hundred and two of the most prominent specialists of the world in their various lines busily engaged on these materials—which have rapidly become more and more comprehensive in character. If work in the field should cease—which I hope will not occur—the studies in numbers of important lines will not be completed within ten years, so abundant have been some of the materials already supplied.

Special acknowledgements are due the specialists of Central Europe who have pushed the work ahead with great energy and activity in spite of the staggering economic conditions surrounding them and which in most cases has directly affected their lives in very serious fashion. Under a really terrible handicap they have yet carried out a great number of studies on this material, of the highest possible importance—the results in some cases being of monumental value. In addition to this, they have themselves procured publication in many cases when there was little or no public support for it and often at great personal sacrifice.

Out of this fundamental and absolutely necessary work in Malaya, is now coming much that will open up profitable lines of biological inquiry, and much that will lead to results of economic importance.

It is a matter of the profoundest regret that funds can not be found to keep the publishing up to date. The titles listed below represent only a part of the work actually finished at this time. Most notable works by Gebien, Heller, Obenberger, Krekich-Strassoldo and many others, still lie in manuscript awaiting publication. It has been hoped that enough interest among Americans could be aroused in this great undertaking in an insular possession and in one of the most interesting and important zoological regions of earth, to attract to it active support in the direction at least of publication. With the inspiring example of the Central European specialists before us it seems that we ought to find ways at least to give to the world the results of their splendid efforts under great difficulties—by comparison almost anything should be possible to people in really comfortable circumstances.

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1 One hundred sixty-five titles in seven years.

2 Seventy-six titles in about four years.

3 Sixty-two titles in the present list, or three hundred and three in all.

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1922.—New or little known Tipulidæ from the Philippines (Diptera). Philipp. Journ. Sci. **21**: 373-384.
1923.—Undescribed Crane Flies from Formosa and Luzon (Tipulidæ, Diptera). Philipp. Journ. Sci. **22**: 467-481.

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BAKER, C. F.
1923.—The Jassoidea related to the Stenocotidæ with special reference to Malayan species. Philipp. Journ. Sci. **23**: 345-401.
1923.—Comparison of Neotropical and Palæotropical Insect Faunæ. Philipp. Journ. Sci. **23**: 531-532.

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1923.—Some New Malayan Carabidæ, especially Philippine. Philipp. Journ. Sci. **23**: 295-305.
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ADDENDUM

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1923.—A New Papilio from the Philippine Islands. Entomologist, **56**: 273.

In these later days the discovery of a new *Papilio* is quite an entomological event. The present species, *Papilio benguetana*, was discovered by C. F. Baker, at high altitude on Mount Santo Tomás at Baguio, Benguet Sub-Province, Northern Luzon. The authors do not extend to the discoverer the simple courtesy or justice of even mentioning his name.

STUDY OF RHIZOCTONIA BLIGHT OF BEANS[1]

By Cipriano C. Nacion

INTRODUCTION

In the Philippines, *Rhizoctonia* causes serious diseases of beans (*Phaseolus* spp.) and of many cultivated plants that have a mat forming habit. To a less extent the fungus is found on plants of a succulent nature, such as eggplant (*Solanum melongena* L.), maize (*Zea mays* L.), camote (*Ipomœa batatas* Poir), sugar cane (*Saccharum officinarum* L.) and rice (*Oryza sativa* L.), etc. Grasses growing on infected soil are often attacked. Also seedlings of succulent plants growing in damp habitats if they are crowded. The attack of the fungus is most serious during the rainy season, at which time the fields of beans are often entirely destroyed. *Rhizoctonia* is sometimes found associated with *Pythium*, a fungus which also attacks seedlings and young plants. In certain portions of the College fields during the latter part of the rainy season of 1921, the mungos, *Phaseolus mungo* Linn., used as a cover crop between the rows of *Averrhoa*, were so heavily infested with *Rhizoctonia* before the plants reached the flowering stage that they could not attain normal height. The fungus is undoubtedly the most common cause of the rotting of tobacco seedlings in the Philippines.

This *Rhizoctonia* has hitherto not been studied closely enough for the definite determination of its species.

THE DISEASE

GEOGRAPHICAL DISTRIBUTION AND ECONOMIC IMPORTANCE

The distribution of *Rhizoctonia* diseases is world wide. They seem to be more serious in regions where the climate is rather moist. Temperature apparently has little effect on the distribution of the disease.

On the American continents *Rhizoctonia* diseases are widely distributed in Brazil, United States, Canada, and some parts of Mexico. In Europe they seem to occur commonly from southern France eastward to Bavaria and Hungary and southward to the Mediterranean and from Germany and central France northward through Denmark, Norway, and Sweden. The fungus has been reported from Australia, Java, New Zealand, Japan, India, and some parts of Africa.

Reinking (1) reported *Rhizoctonia* blight of bean from the Philippines in 1918.

EXTENT OF DAMAGE IN THE COLLEGE FIELDS

Observation of the damage produced by the disease was made on young beans used as cover crop and on soy beans planted on the trial beds in the College fields. The writer observed that about 40 per cent of the young beans succumbed to the disease. On soy beans, planted in the trial beds, the loss caused by the attack of the fungus on the leaves and pods was about 30 per cent. The writer had occasion to observe the ravages of the disease on seed beds of tobacco

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[1] Thesis presented for graduation from the College of Agriculture, No. 163; Experiment Station contribution No. 209.

Prepared in the Department of Plant Pathology under the direction of Associate Professors C. G. Welles and Frank P. McWhorter.

and garden plants in the province of Pangasinan; there the loss due to damping off was estimated to be 40 per cent.

During damp weather the disease spreads with such remarkable rapidity that it is likely to become epidemic in character.

SYMPTOMS OF THE DISEASE

IN EARLY STAGES

There are several modes of infection of the disease. The fungus may gain entrance to the plant at the surface of the soil, attacking first the base of the stem and then the younger portions of the host. Sometimes in the case of procumbent hosts, the growing points and very young leaves become infected when they come in contact with the soil. Apparently ants and other animals, water, wind, and farm implements serve as carriers of the fungus. Another and frequent means of infection is by diseased parts of plants falling over and touching healthy plants. When infection takes place in this way it generally starts at leaf tips, then spreads to the tender stems and even to the more matured stems. Injury of the stems or leaves is not necessary for infection; the fungus is able to penetrate through unbroken epidermal structures. In mature plants the infection is aerial.

In the case of soil infection, the most common source, the first appearance of the disease is the discoloring of the stems just above the surface of the soil and the permanent wilting of the leaves.

IN LATE STAGES

On the decaying stems and leaves of young plants a whitish mass of mycelium is apparent. On such young plants the fungus does not form any sclerotial bodies. On older hosts, where the tissues are old and contain lignified sclerenchymatous cells, the sclerotial bodies are formed within a short time after infection. Such hosts, in severe cases, are first covered with a dense whitish mass of mycelium. Later, white soft sclerotial bodies appear on the surface of the decaying leaves and stems. These bodies soon turn brown and hard and exhibit different forms, some rather spherical, some flattened with a diameter of one to three millimeters and a length of about six millimeters. They drop to the ground with the decaying leaves and stems and hibernate in the soil from season to season without losing their vitality. From these sclerotia under favorable conditions the mycelia are produced.

Shortly after the first appearance of the disease on the host the leaves and stems turn brown producing a soft watery mass in which numbers of protozoa (*Sarcodina* and *Infusoria*) may frequently be demonstrated. On the pods of beans ulcerations are produced at first; then the entire pods are covered with the mycelium of the fungus. When a host is severely infected it almost always dies.

The complete destruction of the host tissues is due partly to the saprophytic action of the *Rhizoctonia* fungus itself and partly to numerous bacteria that work with it.

CAUSAL ORGANISM

METHOD OF ISOLATION

The fungus was easily isolated by putting sclerotia obtained from the decaying stems and leaves of the patani (*Phaseolus lunatus* L.) on corn meal in petri dishes incubated for twenty-four hours. From this young mycelial growth of the fungus transfers were made into potato agar slants.

CULTURAL CHARACTERS OF THE FUNGUS

The growth of the fungus on different media was studied in the laboratory. Observations were made daily for one month and then weekly for about two months. For purposes of comparison it was found necessary to start all the cultures with approximately equal sized sclerotia or bits of mycelium.

Potato agar.—On May 13, 1922, sclerotia of approximately equal sizes were transferred to potato agar slants. In three days, clusters of soft, white, rounded sclerotia were seen developing; these turned hard and black after seven days. Numerous sclerotia were formed. After twenty days both mycelium and medium turned black.

Growth on oat agar.—On May 13, 1922, transfers were made to oat agar slants. After two days white soft sclerotia began to develop; they turned hard and black after seven days. New sclerotia continued to form for twenty days. These sclerotia were larger in size than any of those formed in the other media used; they were of the same size as those found on the host, patani. After one month the fungus filled two thirds of the test tube with a brown feathery mass of mycelium.

Growth on rice agar.—On June 14, 1922, equal sized sclerotia were transferred from patani to rice agar slants. After four days young, white soft sclerotia were developed in clusters which later on became hard black masses. The mycelium turned brownish after twenty days.

Growth on potato-glucose agar.—Bits of mycelium of approximately equal size were transferred to potato-glucose-agar slants. In three days white soft sclerotia were produced. After twenty days numerous hard, black, and somewhat rounded sclerotia were seen. After a month the mycelium and medium turned reddish brown.

Growth on sterilized old stems and pods of Phaseolus lunatus.—The growth of the fungus on the stems and pods was rapid exhibiting the same characteristics as on oat agar slants. The sclerotia were large and rounded but dark brown in color like those found on infected hosts in the field. After one month the fungus filled two thirds of the test tube with a brown feathery mass of mycelium. Numerous sclerotia were formed.

Growth on sterilized young pods and stems of Phaseolus lunatus.—On each of these media the fungus showed a poor growth. After four days, scanty, white, radially growing mycelia were noted. The mycelia were never dense although the individual strands were long, covering almost the entire surfaces of the media. Very few sclerotia were developed. After twenty days the mycelia turned brown and the media decayed.

Growth on plain agar.—Although several transfers were made no growth was obtained on plain 1.5 per cent water agar.

MORPHOLOGY OF THE FUNGUS

A morphological study of the characteristics of the hyphæ and sclerotia was made.

The hyphæ of the fungus are extracellular and intracellular. The external development of the hyphæ is more or less web-like. The color is usually yellowish brown but when young they are practically colorless. Under a four millimeter lens the young hyphæ may be seen to be somewhat vacuolate. They are septate and the distances between the septæ are irregular. Measurements

show that the cells of the hyphæ are 102-200.6 microns × 7.8-9.2 microns. It was found that cells of the young hyphæ are short and become longer as they grow old. Branches arise on these hyphæ at any free end. When young they are inclined in the direction of growth of the main hyphæ and are constricted at the point of union with the main hyphæ. As they advance in age the hyphæ become darker, more uniform and rigid. The branches in the old mycelia are almost at right angles to the main axis.

The hyphæ which are intracellular are colorless and this color remains as long as there is active growth. They are vacuolate. They exhibit the same general characteristics as those of the extracellular hyphæ.

The sclerotia vary in size. The largest noted was 4 millimeters in diameter. They are generally flattened and irregular. When young they are smooth, white and soft, and when old they are smooth, black and hard. The cells in the sclerotia form a homogeneous structure.

In young cultures the hyphæ are colorless, vacuolate with rather irregular septæ. They show the same characteristics as those on the host.

The sclerotia in cultures are similar in appearance and structure to those on hosts in the field.

TAXONOMY

From the microscopical examination of the mycelium and the sclerotia of the organism, it was found that the characters of the hyphæ and sclerotia, conform closely to those of Duggar (2) for *Rhizoctonia solani* Kühn.

The measurements of hyphal cells of the fungus given above are very close to those of Duggar which are 100-200 microns × 8-12 microns.

Morphological and cultural characters indicate that the Phillippine *Rhizoctonia* is *R. solani* Kühn.

PATHOGENICITY

With pure cultures of the organism taken from its patani host, inoculation experiments were made to determine possible hosts and the effect of the organism on them under controlled conditions. In this work, a series of experiments were carried on in the laboratory of the Department of Plant Pathology. All possible precautions were taken to prevent contamination.

There were three methods of inoculation used: (1) Inoculation through slits in stem; (2) inoculation through punctures on leaves; (3) inoculation from the soil.

INOCULATION THROUGH SLITS IN STEM

Three seedlings each of patani (*Phaseolus lunatus* Linn.), mungo (*P. mungo* Linn.), cowpea (*Vigna sinensis* Linn.), and soy bean (*Glycine max* (Linn.) Merr.) were inoculated in August 9, 1922, with a pure culture of the fungus. The stems were sterilized with mercuric chloride (1:1000) and after 10 minutes washed with three changes of sterile water. Small slits were made in the stem with a sterile sharp-pointed scalpel, and bits of mycelium of the organism used were inserted into the slits by means of a sterile platinum needle. Control plants were maintained for each case. The experiment was conducted in a damp chamber.

The plants inoculated were all infected within two days. This was shown by blackening on one side or around the stem at the place where slits were made. These black portions were moist, and sticky fluids oozed from the slits. After one week the plants fell over; death followed four days later. The plants were

reduced to a soft mass covered with whitish mycelium. Later, sclerotial bodies were produced which showed definitely that the destroying organism was a *Rhizoctonia*. The causal organism was re-isolated and was found to be identical with the one in the culture.

INOCULATION THROUGH PUNCTURES ON LEAVES

On August 18, 1922, the same varieties of beans were inoculated using three healthy seedlings of each.

Bits of mycelium were placed on punctured and unpunctured leaves. Control plants were also maintained. The experiment was carried on in a damp chamber. Within two days the plants showed symptoms of blight. The infected leaves were at first somewhat yellowed in blotches. Then they gradually turned black, became moist, and fell to the ground in a soft mass. Both punctured and unpunctured leaves were infected. Within one week the plants fell over in a soft mass and decayed. White masses of mycelia formed a covering on the decaying plants and later on sclerotial bodies were produced which confirmed the infection. The control plants were not infected. The fungus was re-isolated.

INOCULATION FROM THE SOIL

On August 14, 1922, three sound seedlings each of patani and cowpea were planted in sterilized soil and inoculated with the fungus after the seeds were planted. On August 19, 1922, three sound seedlings each of mungo and soy bean were inoculated in the same manner. These seedlings and suitable controls were kept in a moist chamber.

After five days there were characteristic ulcerations on the stems of the seedlings just above the surface of the ground. These ulcerations, which were moist and black, either extended around the stem or were confined to one side. Within two days from the first appearance of the disease, the plants, although the leaves were not wilted, fell over. The attack of the fungus continued until the entire plants were reduced to soft shapeless heaps covered with white masses of mycelium which eventually produced sclerotial bodies. In some instances it was observed that seedlings developing on infected soil were destroyed before they reached the surface of the soil. Such cases were due to the attack on the plumules. The control plants remained healthy. The organism was re-isolated and it was found to be identical with the original organism.

Further inoculation experiments carried on in a damp chamber showed that the fungus isolated from patani was able to kill seedlings of *Nicotiana tabacum* Linn., *Arachis hypogœa* Linn., *Ipomœa batatas* Poir., *Zea mays* Linn., and *Capsicum* spp.

COMPARATIVE PATHOGENICITY OF THE PHILIPPINE RHIZOCTONIA AND R. SOLANI

On October 14, 1922, three sound seedlings of potato were inoculated with the fungus, and at the same time three other sound seedlings of potato were inoculated with a culture of *R. solani* Kühn, obtained from the United States Department of Agriculture, Washington, D. C.

After taking precautions to prevent contaminations sclerotial bodies were placed upon the leaves and tender portions of the stems. The plants inoculated with the Philippine strain were placed side by side in a damp chamber with the plants inoculated with *R. solani* Kühn. Control plants were maintained in both

cases. By October 15, the seedlings were infected. Yellow blotches appeared on the leaves and the stems began to rot and turn black gradually. Six days after the first appearance of the disease the seedlings fell over and decayed. White masses of mycelia were seen on the decaying plants in both cases. The mycelia turned brown as they became older. Both organisms similarly attacked the hosts and killed them almost at the same time. The control showed no signs of infection.

In the comparative inoculation experiments the Philippine and American strains produced identical symptoms of the disease.

DISCUSSION OF RESULTS

The inoculation experiments showed that the Philippine *Rhizoctonia* readily infects succulent plants. The diseased portions produced on all the hosts were identical in nature. The chief characteristics were moist black spots and subsequent rotting.

The results of inoculating the plants through punctured leaves showed that the organism was able to cause infection and blight on the leaves of the host within one day. The fungus killed the hosts in about the same time. Only one general type of disease was produced on all the hosts.

The results of inoculations through the soil showed the production of the characteristic ulcerations on the stems just above the surface of the soil. The length of time required to produce the ulceration was less than five days and within a short time thereafter the fungus killed the hosts. There were no apparent variations in the incubation periods of the disease on each of the hosts. The seriousness of the disease was the same in all cases.

Other inoculation experiments showed that the fungus under favorable conditions may infect not only beans but also many succulent and some woody plants. In the case of succulent plants, crowding and damp soil favor the disease. Ants or other animals, water, wind, etc., are means of disseminating the fungus.

Wet soil, damp air, and crowding of seedlings were found to be favorable for the proper and rapid development of the disease. Sunlight will retard the growth of the fungus. During rainy days the disease developed rapidly and natural field infections were prevalent.

It was also found that the Philippine strain of the fungus attacks potato in the same manner as a known culture of *R. solani* Kühn. It appears that the Philippine fungus is *R. solani* Kühn.

CONTROL MEASURES

From the results given above and observations, several control measures may be recommended.

1. Avoid thick planting and the matting of plants on the ground.
2. Planting should be done so as to escape the rainy season since the disease is severe during the wet months.
3. Crop rotation should be practiced inasmuch as sclerotial bodies fall to the ground and remain alive for a long period. In the crop rotation plants should be grown that do not form a mat over the ground.
4. Avoid planting or germinating seeds on unsterilized soils.
5. Sanitation should be practiced.

SUMMARY

1. There is apparently only one species of *Rhizoctonia* found on *Phaseolus lunatus* in the Laguna region.

2. This fungus kills its hosts within a short time. It attacks all succulent plants that have a mat-forming habit.

3. The fungus is very virulent during the rainy season and will attack any crop that forms a mat over the ground.

4. The types of disease induced are damping off and root or stem rots.

5. The mycelium and the sclerotia, as well as the general appearance on the host and the way it attacks its host, show that the Philippine species of *Rhizoctonia* is *R. solani* Kühn.

6. The fungus is readily culturable by the usual laboratory methods.

7. This fungus is found among the beans and other plants in the College fields.

8. No perfect stage of the fungus was observed.

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SOME METHODS FOR PRESERVING MANGOES[1]

By Calixto T. Zamuco and Patricio Lomibao

By residents of this country the mango has long been recognized as the most delicious of the Philippine fruits. But its superior qualities are little known outside the tropics as it is not exported fresh in any quantity, and little has been done in finding out methods for preserving the fruit.[2] As the mango quickly decays, the poor refrigerating facilities at present do not warrant making any attempt to export this fruit, fresh.

The object of the experiments reported in this paper was to find out a good method of preserving mango and thus make it available for export.

MATERIALS AND EQUIPMENT

The "carabao" variety of mango, the best grown in the Philippines, was used in this work. The fruit was obtained from Pangasinan Province. The average size of this mango is about 15 centimeters in length and 8 centimeters in diameter. It weighs approximately 260 grams when ripe. Well-matured mangoes, with either the cavity or the stigmatic point turning yellow, were picked without bruising and allowed to ripen with the least possible disturbance of the bloom.

In the sulphuring and drying processes, drying trays consisting of a wooden frame and bamboo floor were used. Each tray was 52 centimeters long, 37 centimeters wide and 5 centimeters deep (inside measurements). The principle of construction was similar to that followed by Root (1). The trays were provided with cheese cloth covers. The drying fruit was kept as free from dust and insects as possible. Besides contaminating the fruit, the insects may deposit eggs the larvae of which when they hatch ruin the preserved product. Enough ventilation was provided for constant removal of the moisture given off by the contents of each tray (2).

A sulphuring box 53 centimeters long, 38 centimeters wide, and 1 meter high was made from a packing box. It was so constructed that a space 20 centimeters high was left for a sulphuring stove. The trays were fitted into the box and rested upon cleats fastened to the sides of the box, the distance between the cleats being one centimeter more than the depth of each tray. Several holes were made in the top of the box for the escape of the sulphur fumes.

A copra drier was utilized for dehydrating the fruit at an average temperature of 67° C.

A hand sealer was used for sealing the cans.

The materials used in preserving the fruit were flowers of sulphur for sulphuring and refined sugar for making syrup. For dividing or slicing the mangoes, a

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[1] Part of thesis presented for graduation from the College of Agriculture, No. 164; Experiment Station contribution, No. 210. Prepared in the Department of Chemistry. Experiments under direction of Assistant Professor Kenward. Extracts from thesis made and arranged by Dr. F. O. Santos.

[2] Samples of dried mangoes sent by the Tropical Food Products Corporation, Bauang, La Union, to different places in the United States and exhibited twice (1922 and 1923) at the Philippine Carnival, Manila, received favorable comment as to their superior qualities. Considerable quantities of canned mangoes are being put on the Manila market by the Philippine Fruit and Packing Company of Orion, Bataan, with a fair degree of success.

silver plated knife was used as a steel knife discolors the fruit. The equipment also included a thermometer, shellaced tin cans, preserving kettles, waxed paper bags, and waxed boxes.

METHODS OF PRESERVING

PREPARATION OF FRUIT

The mangoes were carefully picked and kept in an inclined position and as close as possible to each other in a clean warm room. In placing the fruit the stigmatic point was upward and the cavity downward so as to allow the sticky juice to ooze out without coming in contact with the fruit.

When the mangoes were yellow and fairly hard, they were considered properly ripened for canning and dehydrating.

Before weighing and labelling, the fruit was cleaned, then classified as to size, degree of ripeness, and freedom from disease. The selected mangoes peeled or unpeeled were cut into halves or quarters and the seeds taken out. They were then dipped at once in a two per cent salt solution for the purpose of preserving the color as well as improving the flavor of the fruit.

Immediately on taking the fruit from the salt solution, it was placed on trays for sulphuring or drying or into the preserving syrup for canning.[3]

SUN DRYING

Without sulphuring.—The first set consisted of peeled and unpeeled mangoes divided into halves and quarters, dried in the sun in separate trays covered with cheese cloth and placed on an elevated bamboo floor. Solar driers may be used instead of trays to effect more rapid evaporation (2).

The second set was similar to the first except that the trays were placed on the sod.

The third set was dried on a cement floor.

In all cases of sun drying, shelters were provided at night to protect the drying fruit from rain or dew.

Sulphuring followed by sun drying.—Caldwell (2) claims that as soon as the flesh of the fruit is exposed to the air, chemical changes in the tissues begin. Some of these changes produce darkening and discoloration of the tissues; others break down the pigments present causing the fading of the characteristic colors and the natural flavor is lost at the same. Many lower organisms always present in the air and upon foodstuffs, such as bacteria and molds which produce rapid decomposition, are certain to begin growth either on the surface of, or inside, the material. These chemical changes and actions of organisms can be checked by raising the temperature of materials from 175° to 185°F. But it is not possible to do this without causing injury to the flesh of the fruit. The rapid heating at this temperature in dry air of freshly cut succulent fruit or vegetables causes the bursting of the cell membranes by expansion of their contents and permits the dripping of water which carries with it dissolved sugar, salts, and flavoring substances thus affecting both the palatability and the food value of the product. Consequently only moderate temperature can be employed. Unfortunately, practically all the changes under discussion are not only allowed to continue but are also hastened when the temperature of the fresh water-filled material is raised

[3] Drying is a technical term for sun drying; evaporating, for drying fruits by artificial heat (3).

to the limit beyond which bursting and dripping will occur. To arrest these changes and to preserve the natural color and flavor of the fruit, it is necessary to resort either to blanching or sulphuring. For these reasons, the following sets of experiments were undertaken.

The fourth set was divided into four classes: (a) the mango halves unpeeled; (b) the mango quarters unpeeled; (c) the mango halves peeled; and (d) the mango quarters peeled. All of these classes were sulphured for twenty-four hours and then sun dried on a bamboo floor.

The fifth set consisted of peeled mangoes quartered, sulphured for two hours before sun drying.

The sixth, seventh, and eighth sets were also peeled and quartered and sulphured for one and one-half hours, one hour, and one-half hour, respectively before sun drying.

DRYING BY ARTIFICIAL HEAT

The following sets of experiments were conducted to determine: (a) whether a better quality of fruit could be obtained; (b) whether the period of dehydration would be less than that of sun drying by using artificial heat and working independently of weather conditions; (c) whether the mango could be dehydrated successfully without sulphuring.

The tenth set of peeled and quartered mangoes was dehydrated without sulphuring.

The eleventh set was sulphured for one hour and then evaporated.

The twelfth set was sulphured for one-half hour and then evaporated.

In drying and evaporating, the fruit was turned occasionally to prevent its scorching and sticking to the bottom of the trays and to insure uniform drying. Experience alone enables one to determine the right intervals between turnings (3). In this work the drying mangoes were turned every two hours in the beginning of the operation and more frequently towards the end.

To be able to recognize when the fruit is properly dried is also a matter of experience. A good practical test is to take a handful of slices, press them together firmly into a ball, if "springy" enough to separate at once upon being released from the hand the fruit is sufficiently dry. Another test is when no free juice is visible when freshly cut sections of the dried materials are pressed hard (3).

TREATMENT AFTER DRYING

All mangoes sun dried or dried by artificial heat were allowed to sweat in a warm dark room.[4] They were placed in the trays properly screened with cheese cloth. Every day or two the dried materials were stirred thoroughly until the moisture content of the entire mass became uniform and the fruit neither absorbed nor gave off measurable quantities of moisture. The aim here was to equalize the moisture content of every piece of dried mango, because no matter how much care was exercised in drying, some portions contained too much moisture for storage, while others seemed too dry.

After curing, each set of mangoes was placed separately in waxed paper bags properly labelled and sealed with paraffin. The bags were then packed in tins, lined with layers of paraffin paper, each layer being so placed that the join-

[4] Caldwell claims that light destroys the color of the fruit (2).

ings of the preceding layer were broken. The upper edges of the paper were left long enough to be folded over the top when the tin was filled with mangoes. The tins were wrapped with waxed paper and sealed with paraffin.

CANNING

It is claimed that the original form, flavor, color and texture of fruit are retained to a greater degree by canning than by any other means of preservation (4). To determine which was the best, three different syrups were used in canning the mangoes: (a) thin; (b) medium; and (c) thick syrup.

Thin syrup.—The thin syrup consisted of one part water to one part sugar by volume. This mixture was heated to the boiling point. The fruit was then dropped into the syrup and boiled for five minutes. This open kettle cooking reduced the volume and seemed to toughen the tender fibers of the fruit. Shellac lined cans were filled and sealed with a hand sealer, then stored.

Medium syrup.—The medium syrup consisted of three parts sugar to two parts water by volume, heated until the boiling point was reached. This mixture was boiled for five minutes before dropping in the halved mangoes. The cooking, canning, and storing were the same as with the thin syrup.

Thick syrup.—The thick syrup was prepared by mixing two parts of sugar with one part water by volume, heated gradually until the boiling point was reached. This mixture was allowed to boil for ten minutes before the halved mangoes were dropped into it. Then the fruit was cooked for ten minutes in this syrup.

RESULTS

Before packing and for six months thereafter, the dried fruit was closely observed for appearance, attractiveness, etc.; and tasted for flavor and palatability. The color, flavor and other qualities of the fruit were noted when each can was opened. These observations together with the essential points in manipulation follow.

SUN DRIED

Set No. 1a.—Unpeeled mango halves dried with trays on bamboo floor. This group was dried for 58 hours at an average weather condition[5] of 5/12 sunny, 2/12 cloudy, and 5/12 rainy. The percentage of material lost amounted to 74[6]. The dried product was black in color due to molds and was unfit for food.

Set No. 1b.—Unpeeled mango quarters dried with trays on bamboo floor. This group was dried for 56 hours at an average weather condition of 5/12 sunny, 2/12 cloudy, and 5/12 rainy. The percentage of material lost amounted to 81. The dried product was the same as Set No. 1a.

Set No. 1c.—Peeled mango halves dried with trays on bamboo floor. This group was dried for 49 hours at an average weather condition of 3/4 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 85. The dried product was light to dark brown in color, attacked by molds, and unfit for food.

Set No. 1d.—Peeled mango quarters dried on bamboo floor. This group was dried for 48 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 90. The dried product was brown in color, attacked by molds, and quite unfit for food.

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[5] Wind condition was not included because it was practically the same throughout the drying experiments.

[6] Materials lost, include the rind, fibrous seeds, and the moisture evaporated.

Set. No. 2.a—Unpeeled mango halves dried with trays on sod. This group was dried for 65 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 89. The dried product was black in color, badly infested by molds, and unfit for food.

Set No. 2b.—Unpeeled mango quarters dried with trays on sod. This group was dried for 63 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 87. The dried product was black in color, attacked by molds, and unfit for food.

Set No. 2c.—Peeled mango halves dried with trays on sod. This group was dried for 64 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 90. The dried product was black in color, attacked by molds, and unfit for food.

Set No. 2d.—Peeled mango quarters dried with trays on sod. This group was dried for 62 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 91. The dried product was dark brown in color, attacked by molds, and unfit for food.

Set No. 3a.—Unpeeled mango halves dried with trays on cement floor. This group was dried for 44 hours at an average weather condition of 1/3 sunny, 1/3 cloudy, and 1/3 rainy. The percentage of material lost amounted to 83. The dried fruit was dark brown in color, attacked by molds, and unfit for food.

Set No. 3b.—Unpeeled mango quarters dried with trays on cement floor. This group was dried for 42 hours at an average weather condition of 1/3 sunny, 1/3 cloudy, and 1/3 rainy. The percentage of material lost amounted to 90. The dried product was similar in color to Set No. 3a.

Set No. 3c.—Peeled mango halves dried with trays on cement floor. This group was dried for 42 hours at an average weather condition of 1/3 sunny, 1/3 cloudy, and 1/3 rainy. The percentage of material lost amounted to 92. The dried product was light brown in color, considerably infested by molds, edible but quite sour.

Set. No. 3d.—Peeled mango quarters dried with trays on cement floor. This group was dried for 41 hours at an average weather condition of 1/3 sunny, 1/3 cloudy, and 1/3 rainy. The percentage of material lost amounted to 92. The dried product was similar in color to Set No. 3a.

SULPHURED[7] AND THEN SUN DRIED

Set No. 4a.—Unpeeled mango halves, sulphured for 24 hours and dried with trays on bamboo floor. This group was dried for 44 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 74. The dried product was bright yellow in color, fresh, adhered well to the rind which rolled up, but was of questionable food value due to sulphur dioxide.

Set No. 4b.—Unpeeled mango quarters, sulphured for 24 hours and dried as Group No. 4a. This group was dried for 43 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage materials lost amounted to 79. The dried mangoes were similar to Set No. 4a.

Set No. 4c.—Peeled mango halves, sulphured for 24 hours, and dried as Set No. 4b. This group was dried for 41 hours at an average weather condition of

[7] For every 5.65 grams of fresh mango, 1 gram of sulphur was used.

3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 85. The dried mangoes were similar to Set No. 4b with the exception that there was no rind.

Set No. 4d.—Peeled mango quarters, sulphured for 24 hours and dried as Set 4b. This group was dried for 40 hours at an average weather condition of 3/6 sunny, 2/6 cloudy, and 1/6 rainy. The percentage of material lost amounted to 86. The dried mangoes were similar to Set No. 4c except that they were more attractive in color.

Set No. 5.—Peeled mango quarters, sulphured for two hours and sun dried with trays on bamboo floor. This group was dried for 33 hours at an average weather condition of 2/5 sunny, 2/5 cloudy, and 1/5 rainy. The percentage of material lost amounted to 85. The dried mangoes were attractive yellow in color, subacid in taste, smelled of SO_2 and were of questionable food value.

Set No. 6.—Peeled mango quarters, sulphured for one and one-half hours and dried as Set No. 2. This group was dried for 33 hours at an average weather condition of 2/5 sunny, 2/5 cloudy, and 1/5 rainy. The percentage of material lost amounted to 87. The dried mangoes were similar to Set No. 5.

Set No. 7.—Peeled mango quarters, sulphured for one hour and dried as Set No. 6. This group was dried for 33 hours at an average weather condition of 2/5 sunny, 2/5 cloudy, and 1/5 rainy. The percentage of material lost amounted to 86. The dried mangoes were attractive deep yellow in color, sweet, and quite good for food.

Set No. 8.—Peeled mango quarters, sulphured for 1/2 hour and dried as Set No. 7. This group was dried for 33 hours at an average weather condition of 2/5 sunny, 2/5 cloudy, and 1/5 rainy. The percentage of material lost amounted to 87. The dried mangoes were attractive, yellowish in color, sweet, nutty, and good for food.

Set No. 9.—Treated as Set No. 8, but dried on cement floor. This group was dried for 33 hours at an average weather condition of 1/3 sunny, 1/3 cloudy, and 1/3 rainy. The percentage of material lost amounted to 87. The dried mangoes were similar to Set No. 8.

DRIED BY ARTIFICIAL HEAT

Set No. 10a.—Peeled mango halves, unsulphured. This group was evaporated for a period of 21 hours. The percentage of material eliminated amounted to 87.8. The evaporated mango was light-bright to yellowish in color, subacid and nutty in flavor, slightly attacked by molds, and quite good for food.

Set No. 10b.—Peeled mango quarters, unsulphured. This group was evaporated for a period of 14 hours. The percentage of material eliminated amounted to 87.8. The evaporated mango was the same as in Set No. 10a.

Set No. 11.—Peeled mango halves, sulphured for one hour. This group was evaporated for a period of 17 hours. The percentage of material eliminated amounted to 87.6. The evaporated mango was bright yellow to light red in color, subacid, nutty in taste, had traces of SO_2 and was quite good for food.

Set No. 12a.—Peeled mango halves, sulphured for one-half hour. This group was evaporated for a period of 22 hours. The percentage of material elimminated amounted to 87.5. The evaporated mango was attractive yellow to light red in color, sweet to subacid, nutty flavor, and good for food.

Set No. 12b.—Peeled mango quarters, sulphured for one-half hour. This group was evaporated for a period of 11 hours. The percentage of material eliminated amounted to 87.5. The evaporated mango was the same as in Set No. 12a.

CANNED MANGOES

The mangoes in thin syrup were canned May 1; medium syrup, May 2; and thick syrup, May 3, 1922. On July 21, 1923, all the fruit still retained its natural yellowish color, had a flavor varying from subacid to sweet, semi-melting consistency, and retained the semi-firm texture of the flesh. All the three kinds were good to eat; but those in medium syrup were a little too sweet, and those in thick syrup, very sweet, thus affecting the flavor. Even up to November 19, 1922, the mangoes were still in as good condition as in July of the same year.

DISCUSSIONS OF RESULTS

In the unpeeled fruit, the loss due to elimination of seeds and water ranged from 74 to 90 per cent. By taking off the rind, the loss was from 85 per cent to 92 per cent. The reduction in the bulk of the fruit evaporated by artificial heat averaged 88 per cent.

It took less time to dry the peeled mangoes than the unpeeled ones. This was because the rate of evaporation of moisture from the exposed flesh of the fruit was greater than from the part covered by the leather-like rind. A shorter time was required to dry the quartered mango than the halved in all sets of experiments because more surface area of the quartered mangoes were exposed to the air than in the halved.

The evaporation of mango moisture was most rapid with trays on the cement floor, although the weather conditions were more unfavorable (being 1/3 sunny, 1/3 cloudy, and 1/3 rainy) than during the drying on bamboo floors or sod. This is in harmony with Caldwell's explanation that the evaporation of water from grass composing the sod forms a vapor blanket which retards the drying. With the bamboo floor, there was free movement of air currents beneath as well as over the trays which materially aided the drying. Although on the cement floor there was not much circulation of air beneath the trays, there was much more heat absorbed by the cement floor and reflected to the trays, thus contributing heat in addition to the direct rays of the sun. In the absence of a cement floor, a platform elevated a few meters above the level of the ground could be utilized.

It is believed that sulphured fruit dries more quickly than unsulphured (3). In this experiment the unsulphured mangoes dried within 49 hours under Set No. 1c and within 48 hours under Set No. 1d. The sulphured fruits in trays on the same bamboo floor under unfavorable weather conditions dried within 41 hours under Set No. 4c and within 40 hours under Set No. 4d (giving a difference of about 8 hours in each case.) Peeled mango quarters sulphured for one-half hour dried within 33 hours in trays on bamboo floor and with weather conditions more cloudy and rainy than those under which the unsulphured mangoes were dried.

The average length of time required in evaporating by artificial heat was found to be much less than sun drying, the shortest time for sun drying being 33 hours while the maximum time in evaporating was 22 hours, at a temperature of 67°C. The reason for this difference is obvious, as artificial drying is independent of weather conditions; and in this the temperature at which evaporating was done was higher than the temperature in sun drying.

The black color of the unpeeled, unsulphured mangoes was largely due to the presence of mold on the surface of the fruit and to discoloration resulting from the chemical changes within the fruit. The growth of molds was accelerated by the unfavorable weather conditions, two thirds of the time being cloudy or rainy. The molds had ample time to develop before the mangoes became dry enough to prevent their growth. To the same causes are attributed the unattractiveness and unfitness for food of the peeled, unsulphured, and sun dried mangoes.

On the other hand both the unpeeled and peeled mangoes sulphured for 24 hours and sun dried were free from mold and had an attractive yellowish color, but they retained enough sulphur dioxide to make them questionable food material. The rind of the fruit could hardly be removed from the flesh.

The peeled mangoes, sulphured for two hours, one and one-half hours and one hour respectively and then sun dried were free from mold and had an attractive appearance; were subacid and nutty in flavor. Those sulphured for one-half hour were free from mold also and attractive, palatable, and seemingly a wholesome food.

The fruit evaporated by artificial heat and unsulphured had a dark unattractive color, was subacid and nutty in flavor and quite good for food. The molds did not gain a foothold on the fruit while drying.

The peeled mangoes sulphured for one-half hour and evaporated at an average temperature of 67°C. were free from mold and were the best dried product obtained. The fruit was attractive, yellowish to light red in color, nutty sweet and palatable, hence good for food.

Of the canned mangoes those preserved with the thin syrup retained their natural yellowish color, were subacid in flavor, semi-melting consistency and semifirm texture. Hence, they were good for food.

Practically the same good qualities of the fruit were observed in the medium and thick syrup, except that the natural flavor of the mangoes was affected by the increased sweetness of the syrup.

SUMMARY

(1) The great advantage of drying or evaporating mangoes over any other means of preservation is the immense reduction in bulk of the fresh fruit.

(2) Mangoes at the stage of proper ripeness when peeled, quartered, and sulphured for one-half hour, dried more quickly than when not sulphured and gave up their moisture more rapidly in trays on a cement floor than on either bamboo floor or sod.

(3) The same kind of mangoes as described in (2) but evaporated independently of weather conditions by using artificial heat at an average temperature of 67°C. proved to be better in appearance and flavor than was obtained by sun drying.

(4) Canned mangoes with thin syrup retained their attractive natural color, subacid to sweet flavor and semi-melting consistency to a greater degree than by any other method of preservation tried.

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SEEDINESS IN PINEAPPLES[1]

By J. E. Higgins

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The occurrence of seeds in pineapples has given rise recently to considerable inquiry and concern on the part of some who are interested in the pineapple industry. The Cayenne variety which is the foundation of the world-renowned Hawaiian industry, and is grown extensively in Queensland and other parts of the tropics and sub-tropics has been considered a practically seedless variety. Only a little more than a decade ago seeds in the Hawaiian pineapple plantations were considered curiosities by the layman and were eagerly sought by the plant breeder as a possible source of new and valuable varieties. Today they are occurring with a frequency which has caused some uneasiness, for seeds in a pineapple are distinctly objectionable because of the inconvenience and undesirable appearance to which they give rise.

The Cayenne pineapple was introduced into the Philippines from Hawaii and one or more plantations of commercial importance are now in operation. A statement has become more or less widely circulated that seediness is more common here than elsewhere. Those who are interested in the development of the pineapple industry and are cognizant of the vast areas in the Philippines that are adapted to the crop are concerned to know whether this is in accordance with the facts. I have been asked for an opinion on this subject. After four years of residence in the Philippines during which time I have visited the most important plantings and have grown the variety at the College of Agriculture, I have found no evidence that seeds in the Cayenne occur more frequently here than in Hawaii when grown under similar conditions. These findings have been confirmed by men most closely in touch with pineapple growing here including those who have no financial interests in the industry.[2]

The cause of this false impression, which apparently is not of local origin, probably lies in the fact that most of the pineapples which have been canned in the Philippines do contain many seeds. But these fruits are not of the Cayenne variety but rather of a wild or semi-wild form grown in waste places. Until quite recently there have not been enough Cayenne to supply the local market with fresh pineapples and the prices have been so high for these large, juicy, attractive fruits that practically none of the crop was diverted to the cans. The semi-wild pineapple is grown by the Filipino farmer in the shade of other plants where it receives little or no care or cultivation other than the occasional cutting away of the grass and underbrush. But considerable quantities of fruit in the aggregate come from these sources and such has been bought and canned. All this is now being changed as the quantity of Cayenne fruit is increasing and the latter will soon entirely replace the inferior and seedy variety.

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1 Experiment Station contribution No. 211

2 The subject has been discussed with Mr. B. A. Green and Mr. George C. Sellner both of whom have had long experience in the pineapple business in the Philippines and with Mr. Teodorico P. Reyes and Mr. Leon G. Gonzalez of the Agronomy Department of the College of Agriculture and with others.

There are several other varieties of pineapple grown in the Philippines, including the Queen and a number of strains of the Spanish (Red Spanish). Some of these forms produce seeds abundantly and the Spanish is frequently seen in the Manila market with the so-called native variety and occasionally a few others. In recent years there have been many Cayenne.

CAUSES OF SEEDINESS IN PINEAPPLES

In seeking an answer to the inquiry as to the cause of seediness in the Cayenne, the question should first be what is the cause of seedlessness for the production of seed is normal. Some varieties of fruit plants are incapable of producing seeds without the assistance of pollen from some other variety. Some are incapable of even producing a fruit crop. This principle is so well known among orchardists that the mutual relations of many varieties have been worked out and certain varieties are known to be effective pollinizers of other varieties. The Cayenne variety of pineapple can produce fruit without the influence of foreign pollen, but under these conditions it seldom matures seed. It has been demonstrated that seeds can be developed in the Cayenne if pollen from certain other varieties is applied by hand. The same is true of other seedless varieties.

However, while it is true that the Cayenne is usually seedless it does not follow that every individual without exception possesses this character. Plants mutate and suddenly new characters appear. It is not at all impossible that an individual may appear possessing self-fecundating flowers even among these asexually propagated plants. These would merely represent bud-mutations and are probably in the direction of earlier forms. Such mutations, or bud "sports" are well known throughout the field of horticulture and have given rise to many valuable new varieties when the mutation has been in the direction of improvement. Undesirable mutations are quite as common as those that present some new desired character. Whatever these characters may be that arise in a bud-mutation, they are likely to be constant when the new individual is propagated by vegetative parts as is the practice with pineapples.

With these facts in mind, let us consider the history of seed occurrence in Hawaiian pineapple growing. For the first years of the industry seeds in the Cayenne variety were almost unknown. Later an occasional fruit was found in which seeds were very abundant and the fruit was discarded by the canners. But the growers as well as the professional horticulturists welcomed them as possible sources of new and valuable seedling varieties that might be resistant to some of the troublesome diseases. The seeds were gathered at first only a few at a time, and later by the hundreds and thousands and were planted under very carefully arranged conditions to insure germination. Later, these seedlings were transferred to the pineapple fields and the growing of such chance seedlings as well as those that have resulted from hybridization carried on intentionally by the breeders has become a very important phase of pineapple investigations in Hawaii. Most of these plants have been set either in the fields of the commercial plantations or adjoining them. Concerning these it is to be remembered that each seedling is essentially a new variety whether of hybrid origin, or otherwise, since the pineapple cannot be depended upon to reproduce its characters accurately through seed propagation. It is also to be remembered that many of the thousands of new varieties are themselves seedy.

The present increased frequency of seed occurrence may be attributable to one of several causes or to a combination of them. Mutation alone might account for a large part of the cases of seediness. Even if only one case of such bud-mutation occurred its effects would go on multiplying indefinitely for from this plant in the first year a crown and several suckers and slips might be planted and in the following years several more from the original plant and a further supply from each of the first generation of the asexually propagated progeny. There are no external characters discovered that are known to be correlated with seediness and hence the plant is not recognized in the field as different from any other and propagating material is taken from it even including the crown before the seedy character of the fruit is discovered, and it is then too late to identify the plant that gave rise to the seedy fruit. Thus, given only a single mutation, there would be in a period of ten or fifteen years a marked increased frequency of seed occurrence even though a considerable portion of the propagating material were not used. It is not improbable, however, that several such bud-mutations may have occurred.

Another known cause of seed production is cross-pollination. As stated above it has been demonstrated that the Cayenne pineapple can be made to produce seed by hand pollinating its flowers with pollen from other varieties. To what degree cross-pollination may take place by natural means when different varieties are planted in close proximity cannot be stated. It is reasonable to assume, however, that increasing the number of varieties in the vicinity of a normally seedless plant would increase the probabilities of the transfer of effective pollen to the stigmas of such plant. Likewise, the increasing of the number of individuals of any fecundating variety would in the same way increase the probabilities of seed formation.

In the early days of the pineapple industry in Hawaii only one recognized variety was grown extensively, although there were several other practically seedless varieties grown for trial on a very small scale. Then it came to be recognized that there were different forms which were regarded as possibly only different strains of the Cayenne. Some of these are known to represent different introductions and are perhaps sufficiently distinct to be classed as different varieties. Each is normally seedless but so far as the writer is informed the effect of the pollen of any of these upon another has not been determined. More than one of these strains or varieties have been planted extensively and in the same field and even the same row. It is not impossible that such may have furnished a basis for cross-fertilization.

But returning to a consideration of the planting of seedlings, it will be seen that whatever possibilities of cross fertilization may normally exist have been increased many thousand fold by the planting of the thousands of different seedling varieties in the immediate vicinity of commercial plantings.

A third possible cause that has been suggested is, that laborers have unwittingly collected propagating material from plantings of seedlings which very often are seedy. This does not seem to me to be a very probable explanation, for two reasons. First, such seedlings have always been planted at least in separate rows and usually in separate blocks and their location has been well known by those who direct the collection of planting material. Second, they

are so different and so varied as to scarcely escape the attention even of ordinary laborers, while those who do this work have had some training in selection.

A fourth possible explanation is to be found in a combination of the first and the second. A bud-mutation may have occurred affecting not the pollen and its effectivity upon its own flower but rather the form of the flower. The pineapple flower, because of its shape, is much less subject to cross-pollination than many other flowers. Even at its maturity the flower of the Cayenne pineapple is tubular and only slightly opened, while the anthers and sitgma are not close to the opening of the corolla but rather protected and hidden by this organ. A mutation affecting only slightly the form of the flower might render it more open and more susceptible to cross-pollination. If such a mutation occurred it also would be multiplied, and if at the same time many varieties with fecundating pollen were in proximity an increase in seediness might be expected.

Of these four possible causes of increased frequency of seed occurrence, the first two appear to be the more probable, the third of very doubtful influence, and the fourth requiring more study of the flowers to see whether any such differences as suggested, or others, do exist, before the significance of this factor can be appraised.

REMEDIES

In so far as these four factors singly or combined may be responsible for the increased seediness, the remedies suggest themselves. If there have been bud-mutations involving the character of self-fertility, it will be possible to overcome the difficulty only by eliminating such plants from the plantations. This will not be an easy task since, as already indicated, the condition of seediness is not discovered until the identity of the plant from which the fruit came has been lost. A very careful study should be made to determine whether there are any external characters of plant or fruit which are correlated with the self-seeding character. Certain unit characters in plants are known to be linked with other characters and this fact is often of great aid to the plant breeder. In this case if there is a visible external character that is linked with the hidden character of seediness, then it would be possible to quickly eliminate any trouble that may have arisen from such a mutation. All plants exhibiting such correlated character could be destroyed or discarded from propagating material. But it may require a great deal of study to determine any such correlation as may exist.

This much seems certain, that any seediness which is due to the self-fertility of the flowers is likely to be perpetuated indefinitely through vegetative propagation if such plants are allowed to furnish planting material. Therefore it would be safest to discard as planting stocks all seed-producing plants that can be found without stopping to determine whether the seedy condition in that particular case is due to the self-fertility of the pollen or to cross-pollination.

Let us turn now to the means of overcoming the effects of cross-fertilization as a cause of seediness. Here it is to be remembered that the effects of the foreign pollen are upon the flower and fruit only, and in no way does such pollen affect the rest of the plant. Hence the trouble is not self-perpetuating and will be eliminated as soon as the fecundating varieties are destroyed or segregated. Therefore no alarm is to be entertained about the future results of the thousands of seedlings that have been planted, provided that they are not used in vegetative propagation and allowed to become mixed with commercial plantings before

their characters are studied. They may cause some seedy fruit while they are being tested but when destroyed their effects cease. Because of the probable influence of their pollen in effecting seed formation in the Cayenne variety or varieties, and because of the possibility of laborers collecting planting stock from them, it would be advisable to segregate all seedlings from commercial plantings during the period of testing. This does not mean anything like a quarantine but merely a separation. In fact some light might be thrown upon this subject by the planting of a few rows of Cayenne among the experimental plants and examining the fruits for seed at harvest time.

Such varieties of seedlings as may be found to have promise for commercial plantings should be studied as to their power to fertilize the flowers of the standard variety or varieties before they are adopted for general planting. Such study might include a test of the pollen of each upon the other where artificially applied and also a close observation of the two when planted side by side but not hand pollinated. If any new variety should prove to be an effective pollinizer of the existing commercial varieties when planted near by this fact would argue strongly against the adoption of the new variety unless it were used for entirely separate plantings.

In this connection also it is to be noted that a new variety otherwise of great promise, should not be condemned and discarded because of its seedy character until the self-fertility of its flowers has been tested. Its seedy condition may be due to cross-pollination. This test can easily be made by bagging to protect the flowers from foreign pollen.

As a further study of the effects of cross-pollination in relation to the present occurrence of seeds, it would be desirable to determine what may be the effects of the pollen of any of the strains or varieties now passing under the name of Cayenne when such pollen is applied to the stigmas of another of these forms so often found near by.

A third hypothetical cause of increased frequency of seed occurrence has been stated to be the possible unintentional use of seedlings in commercial plantings. One measure to be taken to overcome any possible effects of this character has been referred to above, namely, the removal of all such seedlings to an experimental plot by themselves where they would be entirely free from the danger being used for general plantings. In case any of the planters that have grown seedlings have been careless in this matter in the past, the records would probably show where plants from a certain field were set. An examination of such new fields would reveal whether the accident had occurred for there would be entirely new types scattered among the standard sorts. These new types could be destroyed and if it seemed probable that seedlings approaching the standard forms in appearance were also in these fields, the entire field or block could be condemned as a source of further planting material but could be continued for its fruit production throughout as many ratoon crops as usual.

Now may be considered the remedies for any effects that may arise out of the fourth cause which has been stated to be a possible combination of bud-mutation and cross-fertilization. If in any plant or plants a change has arisen which renders the flowers more susceptible to cross fertilization, such mutation might be more easily detected than a change in the character of the pollen. The

possibility of some such change in the formation of the flower having taken place should be kept in mind as a part of the problem to be studied.

In conclusion, it may be said that, without careful study of the problem in the field, it is impossible to state with certainty the causes of increased frequency of seed occurrence but bud-mutation and the increased probabilities of cross fertilization seem to be the most probable influences at work. If this be the case the elimination of the mutants should be attempted and the segregation of the numerous varieties under trial should be made effective as soon as possible. At the same time it is to be remembered that the effects of pollinizers are not far-reaching and self-perpetuating as would be the case with mutants, the evil effects of which are cumulative. Finally, further studies should be made of pollen and of cross-pollination in the pineapple.

PRAYS CITRI MILLIERE, A RIND INSECT PEST OF PHILIPPINE ORANGES[1]

By José Mañalac San Juan

WITH TWO PLATES

INTRODUCTION

There are numerous insect enemies of Citrus in the Philippine Islands. Among these, *Prays citri* Milliere is important because it damages a large amount of fruit. Although so harmful, little attention has been given this pest in this country.

IMPORTANCE OF THE PEST

Prays citri does considerable damage to Philippine pummelos and oranges (lucbans and cajeles), reducing the production and in many cases preventing the development of the fruits. Attacked fruits which may succeed in maturing become unsightly and unsalable owing to the numerous galls in the rind. Unless proper steps are taken to prevent the injury, the value of Philippine Citrus production will continue to suffer great losses every year.

HISTORICAL

The adult was first described by Milliere (1) in 1873 as *Acrolepia citri*, but later the species was transferred by the same author to the genus *Prays*.

In 1907 the same moth was described by Meyrick (1) as *Prays nephelomina*, this author having apparently overlooked Milliere's older species. Meyrick's species is therefore a synonym of *Prays citri*.

In 1913 Essig (2) published a short paper in which he mentioned that the larva of the moth is a serious pest of Philippine oranges. The materials used in this publication were furnished by C. F. Baker, Dean of the College of Agriculture, at Los Baños, Philippine Islands.

In 1914 Quayle (3) reported that the larva of this small moth causes serious damage on the blossoms of oranges and lemons in Sicily and in some less important Citrus sections of Italy. In Messina a large percentage of the blossoms and newly formed fruits were destroyed in 1913.

In 1916 Fletcher (4) recorded *Prays citri* as an injurious pest of oranges and other species of Citrus in Southern Europe. It is known to occur in India, Ceylon, New South Wales, and the Philippines.

OBJECT OF THE PRESENT WORK

The object of the present work was to study the life history, habits, and the extent of damage caused by *Prays citri* on Philippine Citrus fruits, and to devise effective methods of control.

The work was begun in April, 1922, and was continued until February, 1923, in the College of Agriculture. Life history studies were conducted from July, 1922, to January, 1923, partly in the Insectary of the Department of Entomology and partly in the Citrus Orchard of this College.

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[1] Thesis presented for graduation, with the degree of Bachelor of Agriculture, from the College of Agriculture, No. 165; Experiment Station contribution No. 212. Prepared in the Department of Entomology under the direction of Assistant Professor L. B. Uichanco.

EXPERIMENTAL RESULTS AND DISCUSSIONS

LIFE HISTORY

Methods of study.—Infected fruits were collected and confined in glass jars, with the tops covered with cheese cloth. The larvæ when ready to pupate crawled out of the galls and fastened themselves by a loosely woven cocoon on the glass wall, on the rind of the fruit or on other solid objects. The adults after emergence were transferred to another glass jar and here allowed to mate. Each couple was then isolated in a separate receptacle and fresh flowers, young fruits of the host plants, and a piece of cotton moistened with diluted honey were supplied every day. Examination was made daily for eggs and when these were found they were transferred to flower buds, matured open flowers, and young fruits of the food plants in the Citrus Orchard. The experimental materials in the orchard had previously been covered with bags made of paraffin paper to protect them against contamination from outside sources. Daily observation was made during the incubation period.

Egg.—The egg (Plate I, fig. 1) is sub-elliptical, slightly tapering toward one of the poles. It measures 0.2 millimeter in length and 0.12 millimeter in its largest cross sectional diameter. Freshly laid eggs vary in shade from almost colorless to light yellow, becoming darker as they approach the end of the incubation period. Eggs were laid singly, usually at night, and generally on young fruits, although occasional oviposition was observed on flowers. On account of their small size the eggs are very difficult to find even with the aid of a hand lens. The eggs used in the present breeding work were laid during the nights of August 30 and 31, and September 1, 1922.

As shown in Table I, twenty-two eggs were laid by four moths in the Insectary during three successive nights. This number gives an average of approximately two eggs for a moth in one night. Definite data on the total number of eggs laid by one female were not obtained. The incubation, as shown by the same table, was from six to twelve days, with an average of 8.36 days.

As to place of oviposition, it was noted in the present experiments that eggs were most frequently deposited on newly formed fruits, and rarely on flowers. Fletcher (1), speaking of the same Citrus pest in India, and Quayle (3), in the Mediterranean region, however, maintain that the moths oviposit on calices or on flower peduncles.

Larva.—The larva on hatching (Plate I, fig. 2) is white, with a light brownish-yellow head. The segments are well marked. As it grows older, the color becomes first whitish yellow and later, in the full grown larva, light green; the head becomes dark chocolate brown.

The full grown larva (Plate I, fig. 3) has thirteen distinct segments, exclusive of the head; and measures from 4.2 to 5.5 millimeters in length and rarely more than 1.5 millimeters in cross-sectional diameter at its broadest segment. There are three pairs of thoracic legs and five pairs of prolegs. The body is subcylindrical, slightly tapering posteriorly, semitransparent, and sparsely set with fine hairs, which are not visible to the naked eye. The terminal anal segment bears the last pair of prolegs.

The lateral margin of the pro-, meso-, and metanota bear a small subcircular dark chocolate spot. In the mesonotum is a second elongate smaller marking located entally near the first on each lateral margin. Each of the larger spots

measures about 0.09 millimeter in diameter, the smaller 0.09 millimeter long and 0.45 millimeter wide. The abdominal tergites bear a thin brownish red line measuring 0.17 millimeter extending to the lateral margin on either side. This line is lighter in color anteriorly and becomes increasingly darker posteriorly.

The young larva upon hatching bores into the rind and eats the underlying soft tissue. The entire feeding period is spent inside the cortex and when the larva is full grown, it goes out into the open, ceases feeding for a time, and then pupates.

The total length of the larval stage, as shown in Table I, varies from 49 to 58 days, with an average of 53.36 days.

Pupa.—The pupating larva decreases in length due to the contraction of the body. The larva encloses itself in a loosely woven silk cocoon and pupates in this condition. The anal extremity of the pupa is fastened on the host by means of fine silk thread. The pupa (Plate I, fig. 4) measures from 4.8 to 5.5 millimeters long, rarely more than 6 millimeters, and 0.9 to 1.2 millimeters in diameter at its broadest segment. Its body tapers posteriorly. The wings, proboscis, antennæ, and legs are folded close to the body, the apices of the first three reaching the fifth abdominal segment. Eyes are subglobular, each measuring 0.25 millimeter in diameter.

The following data show the daily changes in color of the pupa. The description is based on ten specimens.

First day.—The newly formed pupa is light green; a median subelliptical longitudinal blotch, usually light red and diffused toward the border, extending from the mesonotum to about the fourth or fifth abdominal tergite. The eggs are light brown.

Second day.—General color is darker; dorsal blotch beginning to disappear.

Third day.—Color still darker. Head, ventral portion of the body between the wings, legs, antennæ and abdominal cauda, brownish green. Eyes light brown.

Fourth day.—Light chocolate brown. Abdominal cauda pale yellowish brown. Eyes black.

Fifth day.—General color, dark chocolate brown, more darkly so ventrally between the appendages. Head also darker. Eyes black. Abdominal cauda, light chocolate brown.

Sixth day.—Adult.

During the progress of the present work, pupæ of this moth were found on the surface of the fruit, usually on crevices in the skin, in the sheltered portions of the leaves, and at the junctions of the twigs and branches. The pupal stage under laboratory conditions, as shown in Table I, varies from four to six days.

TABLE I.—*Life history of Prays citri.*

Eggs.				Pupated.	Length of larval stage.	Moths emerged.	Length of pupal stage.	Total length of immature stages.
No.	Laid.	Hatched.	Incubation period.					
			days		*days*		*days*	*days*
A_1	30–VIII–22	6–IX–22	7	27–X–22	51	1–XI–22	5	63
A_2	30–VIII–22	5–IX–22	6	d	....	.....	....	....
A_3	31–VIII–22	6–IX–22	6	25–X–22	49	29–X–22	4	59
A_4	31–VIII–22	6–IX–22	6	2–XI–22	57	7–XI–22	5	64
A_5	31–VIII–22	a	....	.....	....	.....	....	....
B_1	30–VIII–22	10–IX–22	11	31–X–22	51	5–XI–22	5	67
B_2	1–IX –22	9–IX–22	8	3–XI–22	53	6–XI–22	5	66
B_3	1–IX –22	9–IX–22	8	1–XI–22	53	6–XI–22	5	66
B_4	1–IX –22	a	....	.....	....	.....	....	....
B_5	1–IX –22	10–IX–22	9	d	....	.....	....	....
B_6	31–VIII–22	9–IX–22	9	2–XI–22	53	7–XI–22	5	67
B_7	31–VIII–22	a	....	.....	....	.....	....	....
C_1	31–VIII–22	8–IX–22	8	31–X–22	53	5–XI–22	5	66
C_2	31–VIII–22	8–IX–22	8	31–X–22	53	5–XI–22	5	66
C_3	31–VIII–22	a	....	.....	....	.....	....	....
C_4	1–IX –22	a	....	.....	....	.....	....	....
D_1	30–VIII–22	a	....	.....	....	.....	....	....
D_2	30–VIII–22	11–X–22	12	8–XI–22	58	14–XI–22	6	76
D_3	31–VIII–22	10–X–22	10	d	....	.....	....	....
D_4	1–IX –22	a	....	.....	....	.....	....	....
D_5	1–IX –22	a	....	.....	....	.....	....	....
D_6	1–IX –22	10–IX–22	9	5–XI–22	56	10–XI–22	5	70
Minimum....			6		49		4	59
Maximum...			12		58		6	76
Average.....			8.36		53.36		5	66.33

a—eggs remained unhatched.
d—larvæ dead; date not determined.

Table I further shows that the duration of the immature life of the moth varies in the laboratory from 59 to 76 days, with an average of 66.36 days. Likewise, it may be noted that the incubation period lasts from 6 to 12 days, with an average of 8.36 days; larval stage 49 to 58 days, with an average of 53.36 days; and pupal stage, 4 to 6 days, with an average of 5 days.

Adult.—The moth ranges in size from 3.6 to 4.5 millimeters long, with a wing expanse of from 8.4 to 10.2 millimeters. The general color is grayish brown.

The head is light brown, measuring 0.66 millimeter in width. The eyes are black, subglobose, measuring 0.25 millimeter in diameter. Antennæ grayish brown, tapering slightly toward the tip; average length 3.42 millimeters.

The thorax is covered with light brown scales; wings long and narrow, having a broad fringe particularly on the hind wings. Fore wings bear numerous irregular markings which are distributed over the wings; a conspicuous marginal fringe from the apex extending over the distal half of the anal margin. Hind wings membranous, light gray, without spotting, and with marginal fringe on the costal, apical, and outer anal margins. The fore wings measure about 4.6 millimeters long and about 1.3 millimeters wide; the hind wing, about 3.5 millimeters long and 1.2 millimeters wide. Fore and middle legs concolorous with fore wings, stout, shorter than metathoracic pair; the last light brown, measuring about 4 millimeters long.

The abdomen concolorous with the head (except eyes and antennæ), and thorax; from 2.8 to 3.2 millimeters long and rarely a millimeter wide across the broadest segment.

Table I shows the life history of the moth, observations on which were carried under laboratory conditions. Four pairs, designated as A, B, C, and D, were used in this breeding experiment.

A laid eggs A_1, A_2, A_3, A_4, A_5
B laid eggs B_1, B_2, B_3, B_4, B_5, B_6, B_7
C laid eggs C_1, C_2, C_3, C_4
D laid eggs D_1, D_2, D_3, D_4, D_5, D_6

HOST PLANTS

Apparently the insect feeds on all species of Citrus, although oranges and lemons are its favorite host plants. The pest has not been recorded from any other plant genera. The writer succeeded in rearing adults from larvæ found in the rind of the following species of citrus fruits, collected from the College Citrus Orchard and from the neighboring barrios (San Antonio, Maajas, Anos, Mayondon, and Bayog).

1. *Citrus sinensis* Osbeck.....cajel.
2. *Citrus decumana* Linn.....lucban.
3. *Citrus aurantifolia* Swingle.....lime.
4. *Citrus medica* Linn.....citron.
5. *Citrus limonia* Osbeck.....lemon.
6. *Citrus hystrix* DC.....sour orange (unwrinkled variety).

HABITS

The larvæ of *Prays citri* live just beneath the rind next to the pulp. During the feeding period the larva makes a gall in the rind, appearing externally as a tumor-like swelling. The tissue inside the rind is eaten and as the full-grown larva comes out, it eats its way through, leaving a tunnel which opens at the surface. In severe cases 20 to 30 galls, or even more, may be found on the surface of the fruit. In cases where the galls are very numerous the entire surface of the fruit may be covered. These galls are very prominent and oftentimes mar the appearance and affect the keeping qualities of the fruits; the openings furnish excellent germinating places for fungi and shelter for mealy bugs.

Fletcher (1) (4) (5) in India and Quayle (3) in the Mediterranean regions reported that the larvæ upon hatching bore through the interior of the flowers which are destroyed; pupation, according to these authors, usually occurs within the flowers and also in protected places on the leaves or junctions of the twigs and branches. These reports in regard to feeding of larvæ and pupation occurring in flowers have not been confirmed by the writer's observations. The pupation on the leaves and junctions of the twigs was corroborated.

The moth generally flies at night and is attracted to light to some extent. The adults under confinement were found to be inactive during the day. They rested under cover. These adults were observed to live as long as eighteen days, from August 28 to September 14, 1922.

EXTENT OF DAMAGE

Investigations were carried on during August and September, 1922, on the infestation of Citrus fruits by the larvæ of *Prays citri* in the College Citrus Orchard and in the neighboring barrios of San Antonio, Maajas, Anos, Mayondon, and Bayog of the municipality of Los Baños.

The number of fruits in a tree, as given in Table II, were counted and the number of infested fruits recorded. From these data the percentage of infestation was calculated.

As shown in Table II, six species of Citrus were infested by the pest. Of these *Citrus sinensis* appears to be the most susceptible, the degree of infestation ranging from 78.23 per cent to 84 per cent; *Citrus decumana* ranks second, with an infestation of from 45.45 per cent to 83 per cent; third, *Citrus aurantifolia*, from 60 per cent to 68.58 per cent; fourth, *Citrus medica*, from 0 per cent to 66.66 per cent; fifth, *Citrus limonia*, from 3 per cent to 7.14 per cent, and sixth, *Citrus hystrix*, from 0 per cent to 4.54 per cent.

TABLE II.—*Percentage of infestation of fruits on individual trees.*

Citrus spp.	Number of fruits counted on the tree.	Number of fruits attacked.	Percentage of infestation.	Locality.	Date.
Citrus decumana.....	16	8	50	C. A. Citrus Orchard....	20–VIII–1922
(lucban)	10	6	60	C. A. Citrus Orchard....	20–VIII–1922
	22	10	45.45	C. A. Citrus Orchard....	20–VIII–1922
	52	34	65.38	Bayog.....	24–VIII–1922
	28	16	57.14	Bayog.....	24–VIII–1922
	15	11	73.33	San Antonio.....	5–IX–1922
	8	6	75	San Antonio.....	6–IX–1922
	35	28	80	Maajas.....	6–IX–1922
	18	15	83.33	Mayondon.....	14–IX–1922
	42	33	78.5	Mayondon.....	14–IX–1922
	8	5	62.5	Anos.....	2–IX–1922
Citrus sinensis.....	80	65	81.25	San Antonio.....	3–IX–1922
(cajel)	50	42	84	Anos.....	3–IX–1922
	155	120	78.23	Los Baños (proper).	17–IX–1922
Citrus aurantifolia.....	296	203	68.58	C. A. Citrus Orchard....	18–IX–1922
(lime)	184	110	60	C. A. Citrus Orchard....	18–IX–1922
Citrus medica.....	3	1	33.33	C. A. Citrus Nursery....	23–VIII–1922
(citron)	3	2	66.66	C. A. Citrus Nursery....	26–VIII–1922
	2	0	0	C. A. Citrus Nursery....	26–VIII–1922
	5	1	20	C. A. Citrus Nursery....	26–VIII–1922
Citrus limonia.....	50	2	4	C. A. Citrus Orchard....	6–IX–1922
(lemon)	42	3	7.14	C. A. Citrus Orchard....	6–IX–1922
	67	2	3	C. A. Citrus Orchard....	6–IX–1922
Citrus hystrix.....	22	1	4.54	C. A. Citrus Orchard....	2–IX–1922
(unwrinkled variety)	18	0	0	C. A. Citrus Orchard....	2–IX–1922

In order to determine the extent of injury on individual fruits of the six species named, a number of infested fruits of each species was carefully examined. Table III gives the number of swellings or galls on individual fruits.

TABLE III.—*Extent of injury on individual fruits.*

Citrus spp.	Number of attacked fruits examined.	Number of swellings.	
		Maximum.	Minimum.
Citrus decumana.....	5	25	8
(lucban)	10	28	3
	10	20	6
Citrus sinensis.....	20	32	4
(cajel)	10	23	6
	10	12	5
Citrus medica.....	3	5	3
(citron)	4	6	3
	4	5	2
Citrus limonia.....	5	3	1
(lemon)	5	4	1
	5	3	2
Citrus hystrix.....	2	2	1
(unwrinkled variety)	2	1	1
	2	1	1

According to Table III, the largest number of galls was found on *Citrus sinensis*, from 28 to 30; second, *Citrus decumana*, 20 to 28; third, *Citrus aurantifolia*, 12 to 15; fourth, *Citrus medica*, 5 to 6; fifth, *Citrus limonia*, 3 to 4; and the smallest on *Citrus hystrix*, 1 to 2.

DISTRIBUTION

Prays citri, originally described from Southern Europe (1) (3) (4) (5) (6), is now known to occur in New South Wales, India, Ceylon, Italy, Sicily, Southern France, Corsica, Canary Islands, Eastern Australia, and the Philippines.

In the Philippines, according to Prof. C. F. Baker and Prof. H. E. Woodworth, formerly of this College, the insect is found in the northern provinces; Mindoro and Batangas; and the writer found it in Bulacan, Nueva Ecija, Rizal, and Laguna; probably it may be found in other provinces where *Citrus decumana* and *Citrus sinensis* are grown. Prof. J. E. Higgins of this College has noted it in the province of Bukidnon, Mindanao, so that its distribution is general throughout the Archipelago.

TABLE IV.—*Relation of abundance of Prays citri to the fruiting seasons of Citrus decumana.*

Months of the year.	Conditions and extent of fruiting.	Degree of abundance or scarcity of the larvæ.	Remarks.
January	Flower buds beginning to appear; in others, half matured fruits	Fairly abundant	Galls mostly unopened
February	Flowering continuous; young fruits beginning to develop; few matured fruits	Scarce	A large number of galls opened
March	Flowering continuous to less extent; young fruits in abundance; few matured fruits	Beginning to be abundant	A large number of galls opened; galls on young fruits not yet distinct
April	No flowers; young and half matured fruit abundant	Abundant	Galls more prominent on young fruits
May	Maturing and matured fruits; harvest time	Abundance declining	Many galls are opened
June	Matured fruits; end of harvest time	Very scarce	All galls practically opened
July	Flowering to less extent than in previous season	Larvæ beginning to appear in small numbers	No mature fruits
August	No flowers; young and half matured fruits less abundant than in previous seasons	Abundant	Galls mostly unopened
September	Matured fruits; harvest time	Beginning to be scarce	Many galls are opened
October November	No flowers nor fruit	Very scarce or none at all	Not season for lucban
December	Few flower buds appearing; few young fruits	Very scarce, but occur to limited extent	Beginning of heavy fruiting season

SEASONAL OCCURRENCE

In Los Baños the insect breeds during the fruiting season of Citrus. Whenever the trees, especially *Citrus decumana* and *C. sinensis*, are in fruit, larvæ of the moth are found. In order to determine the relation between the abundance of the larvæ to the appearance of fruits of Citrus, observations were made particularly on *Citrus decumana* for a period of one year. The results are given in Table IV.

As Table IV shows, young and half-matured fruits are abundant during April, May, and August; at that time also, *Prays citri* larvæ are found in abundance. From October to December lucban is practically out of season and the larvæ are correspondingly scarce. The table further shows that in January there is a number of half-matured fruits, and the larvæ then are relatively abundant; in February when fruits are maturing and the majority of galls are open, the larvæ again begin to become rather scarce. In March when fruits are produced in large numbers, the larvæ are numerous, as shown by the prevalence of the galls. On the other hand, the larvæ are very rare in June when all galls are practically opened, and continue to be scarce until July, about which time they begin to become abundant again.

CONTROL MEASURES

Not much was done in the present work in the study of the methods of control of the pest. It was the original plan in the earlier part of this study to conduct fumigation experiments on a few blooming and fruiting trees, but the plan had to be postponed for a later investigation. However, spraying with oil emulsion was carried on during August, September, and December, 1922, and January, 1923, on the Citrus Orchard in co-operation with the Department of Agronomy. The spray was not intended primarily for *Prays citri*. The results, however, appeared to be promising and the control of the insect by oil emulsion is worth further study. The insects were most susceptible to the spray during the pupal stage.

Various investigators have suggested that spraying is the only artificial measure that may be employed. Brigante (4), on the basis of his investigation in the province of Salermo in 1912, states that the larvæ of *Prays citri* on the blossoms may, if necessary, be killed by a one per cent solution of lead arsenate. Cimatti (7) in 1913, writing in Italy, gave the following spray formula for the larvæ of *Prays citri* which ruin the orange blossoms: 20 gal. water, 22 lb. molasses, 22 lb. dregs of lime juice essence and 2 gal. water in which 4½ of sodium arsenate have been dissolved.

SUMMARY AND CONCLUSIONS

1. *Prays citri* Milliere is one of the most destructive insect enemies of Citrus in the Philippines. The insect belongs to the family Tineidæ, order Lepidoptera.

2. The eggs are laid singly at night, most frequently on young fruits; rarely on flowers. They are subelliptical, measuring 0.2 millimeter long and 0.12 millimeter in cross-sectional diameter; they vary in shade from almost colorless to light yellow, when newly laid; darker at the end of the incubation period.

3. The full-grown larva measures from 4.2 to 5.5 millimeters long; rarely over 1.5 millimeters across its broadest segment. The body is subcylindrical,

slightly tapering posteriorly, semitransparent and sparsely set with fine hairs. Each abdominal tergite bears a thin red line extending to the lateral margin.

4. The pupa is inclosed by a loosely woven silk cocoon and measures from 4.8 to 5.5 millimeters long; rarely more than six millimeters; from 0.9 to 1.2 millimeters wide at its broadest segment. When newly formed it is light green but becomes dark chocolate brown when mature. Pupæ are found on the surface of the fruits, in the sheltered portions of the leaves, and at the junctions of the twigs and branches.

5. The adult is light grayish brown and measures from 3.6 to 4.5 millimeters long with a wing spread of from 8.4 to 10.2 millimeters; wings long and narrow with marginal fringe particularly on the hind wings.

6. The total duration of immature stages varies from 59 to 76 days; incubation period, 6 to 12 days, average, 8.36 days; larval stage, 49 to 58 days, average, 53.36 days; pupal stage, 4 to 6 days, average, 5 days.

7. The larvæ feed on the following species of Citrus:

1. *Citrus sinensis* Osbeck. (cajel)
2. *C. decumana* Linn. (lucban)
3. *C. aurantifolia* Swingle. (lime.)
4. *C. medica* Linn. (citron)
5. *C. limonia* Osbeck. (lemon)
6. *C. hystrix* DC. (sour orange, unwrinkled variety)

8. The larva is a rind feeder. It lives beneath the surface of the rind next to the pulp, producing tumor-like swellings on the surface of the fruit. These galls are very prominent and are opened when the full-grown larvæ are ready to crawl out and pupate. Pupation takes place on the outer surface of the fruit, on protected portions of the leaves, and at the junction of the twigs and branches. The adults are active at night. Under confinement, adults were found to live for eighteen days.

9. The degree of infestation on the six species of Citrus studied varied greatly; the following species are arranged in the order of their susceptibility: *Citrus sinensis, C. decumana, C. aurantifolia, C. medica, C. limonia, C. hystrix.*

10. The insect breeds during the fruiting season of Citrus, and whenever *Citrus decumana* and *C. sinensis* are in fruit, the larvæ of the pest are found. The larvæ are abundant during April, May, and August, and scarce from October to December.

11. No natural enemies of the insect were observed in the course of the present investigations.

12. Oil emulsion has been found efficacious in killing the insect in the pupal stage.

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ILLUSTRATIONS

(Magnifications given refer to sizes of original figures)

Plate I.

Fig. 1—Egg. × 185
2—Newly hatched larva, dorsal view. × 20
3—Full grown larva, lateral view. × 20
4—Pupa, ventral view. × 20
5—Adult, dorsal view. × 17

Plate II

Pupæ on leaf of *Citrus aurantifolia*

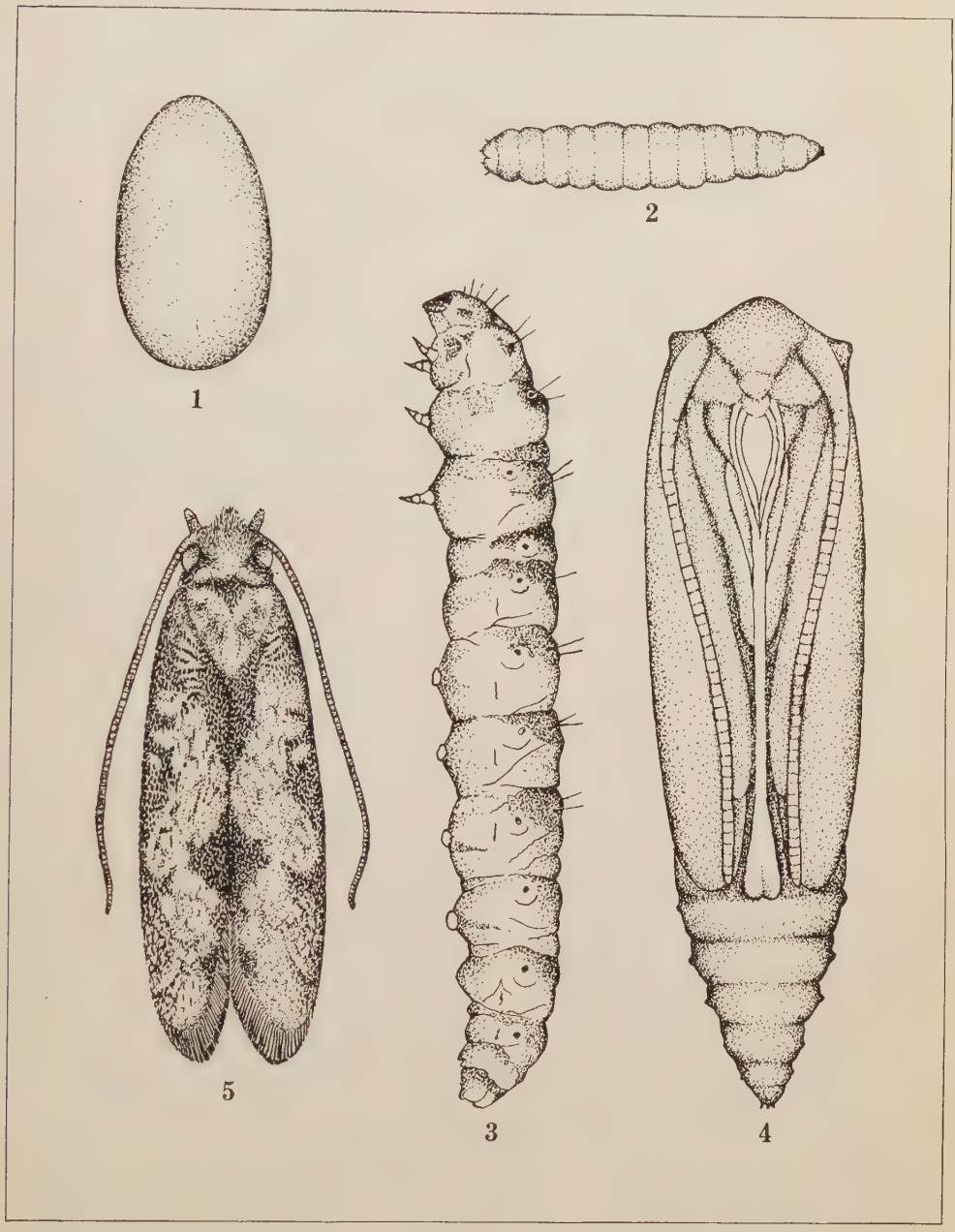

PLATE I

PLATE II

THE EFFECT OF AGE ON THE HATCHING QUALITY OF EGGS[1]

By Martin O. Leoncio

Popular knowledge on the subject of the effect of age on the hatching quality of eggs is very meager in the Philippines as it is a very common practice to set eggs of different ages. And as there has been no investigation on the subject in this College, no Philippine data or literature can be cited.

Though conditions in the Philippines are very different from conditions in the United States, a review of the literature on the subject of incubation in that country may furnish us some valuable information on this subject. Lamson, Jr., and Kirkpatrick (1) working on the effect of age on the hatchability of eggs, found that a greater number of chicks could be obtained from younger eggs than from older ones. Out of 590, 3 to 5-day old eggs, set, they obtained 60 per cent hatch, and from 534, 11 to 12-day old eggs, only 52 per cent hatch. Considering only the fertile eggs, they obtained 71 per cent hatch from the younger eggs and 63.5 per cent from the older ones. From these results they concluded that two weeks may be considered the time limit for holding eggs for hatching. On the same line Waite (2) obtained the results given in the following tabulation:

Age of eggs.	No. of eggs set.	No. of eggs fertile.	No. of eggs hatched.	Per cent of eggs hatched.	
				From all eggs.	From fertile eggs.
Fresh	1261	1200	774	61.38	64.50
5-day	2054	1942	1321	64.31	68.02
10-day	1127	1046	586	51.99	56.02
15-day	499	451	207	41.48	45.89

He observed that the percentage of eggs not hatching showed a fairly consistent increase for all periods longer than one week. He also states that two weeks may be considered, generally, as the longest time under the very best conditions for holding eggs for hatching.

Relative humidity and temperature of the atmosphere are external factors that also have something to do on the hatching quality of eggs. Dryden (3) conducted three sets of experiments, in the first of which the eggs were subjected under an average relative humidity of 48.7 per cent, in the second, the eggs were placed under an average relative humidity of 55.3 per cent, and in the last set he had the eggs under a relative humidity of 64.7 per cent. The average relative humidity of the room where the incubators were operated was 73.4 per cent. The best results were obtained from the second set where the eggs were subjected under medium conditions. Dryden also conducted another experiment along

[1] Thesis presented for graduation from the College of Agriculture, No. 166; Experiment Station contribution, No. 213.

Prepared in the Department of Animal Husbandry under the direction of Mr. Mariano Mondoñedo and Dr. F. M. Fronda.

the same line except that the average relative humidity of the room was only 45.5 per cent. He obtained the best results from eggs that were given a maximum supply of moisture which had an average relative humidity of 55.5 per cent.

The present work was undertaken to carry out under Philippine conditions some of the recommendations of the American workers cited. The objects of the work were:

(1) To determine the time limit of holding hatching eggs under Philippine conditions.

(2) To determine the best age to set eggs in order to produce the maximum number of chicks at a comparatively small expense.

(3) To determine which season of the year is the best to hatch eggs.

The experiment was started in December, 1921, and ended in August, 1922. It was conducted in one of the poultry houses of the College of Agriculture, University of the Philippines, at Los Baños.

MATERIALS AND METHODS

Observations were made on the eggs of the Cantonese and the Barred Plymouth Rock breeds. The eggs were selected from the eggs produced by the flocks of the Animal Husbandry Department of the College of Agriculture. Natural incubation was used in hatching the eggs, and hens belonging to this department were utilized for this purpose. Before a suspected broody hen was given eggs for hatching, preliminary tests were made by placing several old eggs under this hen in the evening, and the next morning, if she proved to be really broody, twelve selected eggs were given her to hatch.

The eggs used were uniform in size, shape, and shell texture. They were kept in a cool, dry, well ventilated box. Before the selected eggs were placed under a broody hen they were properly labeled with their age in red ink. Three fresh-eggs, three five-day old eggs, three ten-day old eggs, and three fifteen-day old eggs were set under each hen. The eggs were tested on the seventh day and on the fourteenth from the time they were placed under the hen.

Nests, made of petroleum boxes, 140 centimeters long, 85 centimeters wide, and 85 centimeters high, were used. The sides were provided with holes for ventilation. Excelsior was used as nesting material. The nest was made slightly deeper at the center than around the edges to prevent the eggs from rolling from under the hen and becoming chilled.

The setting hens were provided with grains of corn and rice, and fresh water was available all the time. They were fed twice every day, morning and afternoon. They were taken out of their nests one by one, and, after about twenty minutes, they were put back on their nests. On the nineteenth day of incubation, the setting hens were not allowed to come out for food and water. A wallow box, containing two parts of dust and one part of lime was provided in the hatching room for the hens to dust themselves.

The weather records used in this work were obtained from the Department of Botany of the College of Agriculture. The time during which the experiment was carried on was divided into three periods. In the first period, the months of December, January, and February, being the coldest, were included. The second period included in the hottest months of the year, March, April, and May, and in the third were included the months of June, July, and August which are the medium months of the year.

RESULTS

The results obtained in this experiment are given in Tables I, II, and III. Table I gives the results with the Cantonese eggs, Table II with the Barred Plymouth Rock eggs, and Table III both Cantonese and Plymouth Rock. In these tables the per cent of infertility was obtained by dividing the number of infertile eggs determined during the first testing by the total number of eggs set, and multiplying the quotient by one hundred. The "dead" includes the eggs that were found dead during the first and second testings, and those eggs that failed to hatch, and the per cent "dead" was obtained by dividing the sum of all those "dead" by the number of fertile eggs in the setting and multiplying the quotient by one hundred. The number of chicks obtained was divided by the total number of eggs and the quotient multiplied by one hundred to get the per cent hatched from all eggs; and to get the per cent hatched from fertile eggs, the number of chicks obtained was divided by the number of fertile eggs only and the quotient multiplied by one hundred.

DISCUSSION OF RESULTS

As may be seen in Tables I and II, the results obtained in both breeds were practically the same. Without exception, the per cent of infertile eggs increased as the length of holding the eggs previous to incubation increased. It is to be regretted that no provision was made to determine during the first test which of these eggs were infertile and the fertile eggs that had started to develop but had died before the change could be noticed through candling. It is very probable in eggs that were kept ten and fifteen days their germ spots started to develop and died before they were placed under the setting hen.

It may also be noted that the per cent of "dead" increased as the age of the hatching eggs increased. This is true in both breeds and in the different periods of the year. The germs that survived till the eggs were set undoubtedly possessed strong vitality at the start, but after having been subjected to the conditions present during the time of holding them, they probably weakened and as a result there were more "dead" in the older eggs than in the younger ones. In both breeds, the per cent of "dead" was less during December, January, and February than during the other two periods in which the per cents were about the same. These differences may have been due to the condition of the birds at the time the eggs were laid. During the months of December, January, and February the birds were probably in a much better condition than during either of the other two periods, as it is medium temperature during these three months and there is always fresh green grass which the birds can get readily, in the leaves of which there is protein.

The per cent of hatchability is the same in both breeds, being highest with the fresh eggs and decreasing as the time of holding the eggs previous to incubation increases. These results may be expected as the longer the eggs are kept before hatching the more moisture evaporates from them, and some changes that are injurious to the germ spot inside the egg takes place. This loss of moisture in addition to the increase in the age of the eggs tends to decrease the vitality of the germ spots, and thereby causes unsatisfactory hatching result. Here, again, the per cent of hatch during the first period, December, January, and February, is higher than during the other periods. This is probably due to the

same cause as was given in the explanation for the differences in the per cent of "dead".

The weather conditions during these different periods may be another explanation for the differences in these hatches. During the first period the average temperature was only 24.4° C., whereas in the second and third periods the average temperature was 27.9° C and 26.4° C respectively. It has been observed that during the hottest months, March, April, and May, and some parts of June, July, and August, the setting hens would leave the nests very often, and it is also very probable that an excessive cooling of the eggs may have been another reason for the lower hatches obtained during these periods.

SUMMARY AND CONCLUSIONS

(1) It was observed that the per cent of infertility increased as the time of holding the eggs previous to incubation increased. This was also true with the per cent "dead".

(2) The best results were obtained from hatching fresh eggs. The per cent of hatchability decreased as the time of holding the eggs increased.

(3) Better hatching results were obtained during the months of December, January, and February, than during March, April, and May, and June, July, and August.

(4) Ten days may be considered a time limit for holding hatching eggs during December, January, and February, but during the hottest months of the year all eggs should be hatched while fresh.

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TABLE I.—*Hatching results with the Cantonese eggs.*

Age of eggs.	December, January, February					March, April, May					June, July, August				
	No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.		No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.		No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.	
				All eggs set.	Fertile eggs.				All eggs set.	Fertile eggs.				All eggs set.	Fertile eggs.
Fresh	44	11.3	15.3	75.0	92.3	93	12.9	18.5	71.0	81.5	24	4.2	21.7	75.0	78.3
5-day	43	30.2	16.6	58.1	83.3	73	17.2	37.6	51.6	62.3	24	4.2	43.4	54.1	56.5
10-day	43	34.9	17.8	53.5	82.1	93	30.1	80.0	14.0	20.0	24	8.4	54.5	41.6	45.5
15-day	40	62.5	53.3	17.5	46.6	93	35.5	93.3	4.3	6.7	24	25.0	100.0	0	0
Weather records	Av. temperature—24.4 C. Amount rainfall—111.4 mm. Av. velocity of wind—610.4 miles.					Av. temperature—27.9 C. Amount rainfall—358.7 mm. Av. velocity of wind—652.5 miles.					Av. temperature—26.4 C. Amount rainfall—705.5 mm. Av. velocity of wind—546.5 miles.				

TABLE II.—*Hatching results with the Barred Plymouth Rock eggs.*

Age of eggs.	December, January, February					March, April, May					June, July, August				
	No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.		No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.		No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.	
				All eggs set.	Fertile eggs.				All eggs set.	Fertile eggs.				All eggs set.	Fertile eggs.
Fresh...	36	16.7	13.3	72.2	86.7	42	16.7	22.8	64.3	77.1	9	22.2	14.2	66.7	85.7
5-day..	36	27.7	19.2	58.3	80.7	42	19.0	47.0	42.9	52.9	9	22.2	57.1	33.3	42.8
10-day..	36	38.8	31.8	41.7	68.2	42	42.9	79.1	11.9	20.8	9	22.2	71.4	22.2	28.5
15-day..	35	51.4	58.8	20.0	41.2	42	45.2	82.6	9.5	17.4	9	11.1	100.0	0	0
Weather records	Av. temperature—24.4 C. Amount rainfall—111.4 mm. Av. velocity of wind—610.4 miles.					Av. temperature—27.9 C. Amount rainfall—358.7 mm. Av. velocity of wind—652.5 miles.					Av. temperature—26.4 C. Amount rainfall—705.5 mm. Av. velocity of wind—546.5 miles.				

TABLE III.—*Hatching results with both the Cantonese and the Barred Plymouth Rock eggs.*

Age of eggs.	December, January, February					March, April, May					June, July, August				
	No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.		No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.		No. of eggs set.	Per cent infert.	Per cent dead.	Per cent hatched.	
				All eggs set.	Fertile eggs.				All eggs set.	Fertile eggs.				All eggs set.	Fertile eggs.
Fresh...	80	14.0	14.3	73.6	89.5	135	14.8	20.6	67.7	79.3	33	13.2	17.9	60.4	71.1
5-day..	79	29.0	17.9	58.2	82.0	135	18.1	42.3	47.3	57.6	33	13.2	50.2	43.7	49.7
10-day..	79	36.9	24.8	47.6	75.2	135	36.5	79.5	13.0	20.4	33	15.3	62.9	31.9	37.0
15-day..	75	57.0	56.1	18.8	43.9	135	40.4	87.9	6.9	12.1	33	18.1	100.0	0	0
Weather records	Av. temperature—24.4°C. Amount rainfall—111.4 mm. Av. velocity of wind—610.4 miles.					Av. temperature—27.9 C. Amount rainfall—358.7 mm. Av. velocity of wind—652.5 miles.					Av. temperature—23.4 C. Amount rainfall—705.5 mm. Av. velocity of wind—546.5 miles.				

CURRENT ECONOMICS OF TROPICAL PRODUCTION: III

THE PHILIPPINE ISLANDS AS A MARKET FOR AMERICAN RICE

Since 1905 the production of rice in the United States has increased from 800 million pounds to over 2500 million pounds. During the same period exports from the United States have increased from 200 million to 2000 million pounds and imports have decreased from 300 million pounds to less than 50 million pounds. The net internal consumption has, therefore, fallen from 900 million to 550 million pounds in the face of open attempts to induce the American consumer to eat the Oriental cereal. The result is that the United States producer is looking for a wider export market, wanting which, he must reduce his acreage. Over a year ago he began to inquire as to the possibility of the Philippine Islands as an export market.

The possibility of the Philippine Islands as a market for the United States rice surplus rests upon an evaluation of numerous factors. The more obvious factors may be listed as: (1) Deficiency in domestic production; (2) Time and credit requirements; (3) Distributive mechanism; (4) Price maximum; and (5) Legislative conditions.

Deficiency in domestic production.—The Philippines have not produced a sufficient supply of their staple cereal since 1854. The possibility of their doing so is remote for the following reasons:

(a) There are numerous competing crops, crops that from time to time become "bonanza" projects and land area, capital, and labor usually devoted to rice is forced to make room for such crops. The war impetus for coconut oil resulted in the conversion of considerable rice acreage into coconut groves and a more considerable area of open grass lands theretofore uncultivated but distinctly suitable for the primary cereal were instead seized upon for coconut plantations. While it is quite simple to convert rice or open area into coconut groves it is quite another thing to later reconvert any part of the groves into rice land. However low the price of copra may fall and however high the price of rice may climb, maturing coconut trees are not at all likely to be uprooted.

High prices for abaca resulted in the abaca regions in a similar conversion of rice lands and while the plowing up of recent abaca plantings is more thinkable than the reconversion of coconut groves, it is still not to be counted upon. Abaca is not, however, quite the land competitor that coconut trees are, for abaca is usually planted on newly cleared hilly land.

A third competing crop is sugar, but rice land once planted to sugar may be changed back to rice with greater ease than in the case of either coconuts or abaca. It must be borne in mind that all three of these crops preceded rice in the chronology of war time price increases and were extended to a greater or less degree at the expense of the great food crop. Tobacco which also preceded rice in the matter of demand stimulation did not compete with it for land, due to definite regional rather than agronomical or economic detail.

(b) In addition to the three crops, coconut, abaca, and sugar having priority in war time stimulation, rice farming is closely bound with several un-

favorable economic and social conditions of production sufficient to offset the significant price differential which now maintains in favor of rice. More than our other crops, rice is the intimate and traditional production of the native inhabitant, the only important food crop under cultivation at the time of European conquest, 1565. And as such, rice is clothed with a pernicious tenancy system involving inheritable bonded debt, usury, and veritable peonage not evident in any relative strength in the economy of other crops. The new Filipino, if we may be enigmatic, finds little attracting to a continuance, much less an expansion, of the existing rice area and its conditions. Nor does the government provide him the means to overthrow or to compete with the existing system.

(c) A third disadvantage of rice culture in the Islands rests on the excessive costs of production. Especially is this true in the harvesting where a man with a week's work on another's field receives as much palay (unhulled rice) for his share as he himself could produce with five times the effort. Recent attempts to lower traditional share allotments for harvesters or to substitute for them almost twice the current daily wage have met with successful resistance. The rice harvester receives at present an average wage in commodity of about three and a half to four pesos a day as against a current daily cash wage of less than one peso. Accentuating this disadvantage is the fact that rice imported from Indo-China is cheaply produced in that labor-seething market and can undersell the cheapest production in the Islands. It is the writer's opinion that no Filipino on a pure basis of dollars and cents in normal times can afford to raise the cereal. There are few cases of financial success among its producers in the Islands. It is only the fear of a break-down in the distribution of imported rice due to poor communications, a thing which has in the past occurred, and the rider that he thereby furnishes against exorbitant prices of the imported article, that lead him to devote his effort and capital to so comparatively unprofitable a crop.

(d) In answer to the notes given above regarding non-expansion of crop area the local rice optimist is inclined to point to wide areas of uncultivated open grass lands in Mindanao and the hinterland of Luzon and exclaim that there is the solution, there the room for expansion of rice land. "Urban dwellers with slightly bucolic minds" see everything in these grass lands. Everything is truly there in potentiality, everything might be there, but the first thing that must be there is communication. The middle west of America was pioneered over those most excellent of watercourses, the Great Lakes, Ohio and Mississippi rivers, and not otherwise. The so-called "Great West" of America received its first material development subsequent to the first transcontinental railways.

(e) Add to this lack of communications the futile character of land alienation laws now governing in the Islands; the right of the Director of Lands to delimit homesteads; the unsuppressed title juggling that has gone on now for ten years; and the inexcusable lack of surveys and titles. Add to it all the ponderable social deterrent of the gregarious non-pioneering habits of the Filipinos who are now the world's most distinctive "townsmen", and doubt must logically exist as to unaided expansion of the rice area of material extent in the near future.

The Philippine Islands will consume annually quite 2½ billion pounds of rice. The per capita yearly consumption is over 200 pounds and the population numbers well over 10 millions. Production in the most favorable years has

reached slightly above 90 per cent of the requirement. The current actual deficiency will fall between 150 and 200 pounds and this deficiency will be made up by imports. The primary and limiting factor, the actual deficiency, is distinctly favorable to importation of rice and will so continue for many years.

Time and credit requirements.—Whatever may be the year's total demand for rice, however acute the shortage in native production, a review of past data indicates that the bulk of imported rice in the Philippines moves during the months from May to October. This is due to the fact that the native crop is largely harvested in December and this stock is depleted before recourse is had to importation except in limited industrial centers where there appears a somewhat greater constancy of demand for the cheaper grades. If American ports contemplate shipment of rice prior to April 1924 to the Islands, the American brokers must be prepared to extend a minimum of six months credits and an average of eight months credits on the bulk of their transactions.

Distributive mechanism.—The distribution of imported rice in the Philippine Islands is effected by means of what we may call, for want of a better term, "guild"—a Chinese rice guild with its apex in French Indo-China (Saigon) and its base in the two to twenty Chinese vendors found in every municipality of the Islands. The middle courses of the pyramid are the Chinese bankers and Chinese brokers in Manila, their branch houses and allied provincial Chinese go-downs. Parenthetically, this same combine controls the milling and distributing of all native rice production that enters into commerce and all other staple foods of native importance. The guild is a complete vertical and horizontal trust, feudal, racial, close-knit, hard-set, ancient, and thorough. It controls warehouses and steamship lines. To the Filipino consumer it is everything that some Americans have feared the "Big-Four" packers of Chicago might become to Americans—with this difference, that because of the distribution of native wealth, the smallness of the same, and the fact that commercial Chinese recognize and are guided by the eventual futility of profiteering, price extortion has never, with few exceptions, been attempted. Moreover, the Chinese trader is a man without a country, politically inconsequential and if his inherent honesty and centuries of tradition did not, as they do, deter him he would yet find it a social and political impossibility to profiteer.

The all-Chinese rice combine must be thoroughly realized by prospective American exporters. It is an extremely sensitive organism, fits its prices to daily conditions, extends to the honest natives an impressive mass of store credit, collectible only in kind at harvest time. The system has an unimaginable facility for minutia and point economy, is completely conscious and reacts to every condition so speedily as to indicate an almost intuitive sensibility. The like and economy of this guild is not to be found in the world outside the Chinese markets in Malaysia.

Needless to say, American exporter can neither compete with nor overthrow the distributive system in the Philippines food market. There remains the question, "Can he invade or make use of it? Can he replace the Indo-China apex with an American apex?" He can *if he may undersell the producers in French Indo-China.* This possibility rests upon six arguments.

(a) American exporters have experienced little difficulty in invading the Chinese retail mechanism to introduce American tinned goods practically to the

exclusion of all other similar items, and to acquire a consequential share of the cotton goods business.

(b) The capital which controls the Philippine distributive combine is in the hands of Chinese merchants and bankers in Manila, not in Indo-China.

(c) The Indo-China producer is mainly European and has little if any racial claim on the Chinese distributors.

(d) The Chinaman buys in the lowest market without sentimental interest (except in the case of Japanese goods).

(e) The Chinaman likes the American with an almost pathetic enthusiasm. If sentiment ever sways the Celestial it will do so to the American's advantage.

(f) There exist a few American firms in the Islands that maintain a liaison between the American exporter and Chinese importer active especially for tinned goods and hardware but potential for expanded relations. These might attempt to break the ground for the prospective rice market. The distributive mechanism might, then, with difficulty be turned towards American rice.

Price maximum. The greatest price at which United States rice might sell in the Philippines is fixed on the basis of two ascertainable facts the determination of which lies outside the Philippines.

(a) The local retail price of rice in the Philippines (common grades, December, 1923) is between three and a half and four cents gold a pound. Let us suppose American exporters undersell at three cents gold a pound, there remains no assurance that Saigon rice would not be offered at two and a half gold. The base price of Philippine imported rice must be the cost of production in French Indo-China and not the trade price in Manila. We do not know and have no way of discovering at the base (consumption) the margin of profit at the apex (production).

(b) The transportation and laying down charges must be equalized. If low incidental or fill-in rates by United States Shipping Board vessels are possible, this can be accomplished. The possible price maximum is unknown at present and unfavorable to American rice exporters. They would have to lay the cereal down in Manila at a price which French Indo-China's production could not meet.

Legislative conditions.—The rice growers of the Philippines have long demanded a tariff on rice, which demand was heeded by the Legislature of 1922. Every cavan (126.5 pounds) of clean rice coming from foreign ports pays $1.50 duty. Rice coming from the United States is, of course, free of duty. The effect of the duty so far has been to peg the retail price of rice at about 4 cents gold a pound rather than to appreciably increase production.

Summary.—American rice producers are in need of an export market; the Philippine Islands has an annual deficiency of approximately 200 million pounds; a tariff favorable to the United States exists; but American participation in the Philippine rice market necessitates long term credits, an invasion of a long-established Chinese distributive organization, *and the production and laying down in Manila of rice at an over-all cost less than that of the French Indo-China producer who is endowed with cheap labor, is nearer the market, and has held it for seventy years.*

Evett D. Hester
Professor of Economics.

AUTOPSIES[1]

By A. K. Gomez

Of the College of Veterinary Science

The teaching of pathology will be of little practical value without autopsies. It is essential that the students taking the course be trained in systematic post-mortem technique and be instructed in the proper interpretation of the lesions produced by a disease as presented in the post-mortem table after death. This will help them materially in making a clinical diagnosis in their practice of medicine.

Very often a veterinarian, whether in private practice or in the field as a government live stock inspector, is called upon to perform the autopsy of an animal dead of an unknown disease. Without the proper training in post-mortem technique, he will naturally experience difficulty in reporting a reliable diagnosis. He will be unable to present a well written and comprehensive protocol on the subject autopsied and may, as a consequence, lose the first opportunity to check the incidence of an epizootic.

To supply this practical training, as supplementary to the course in pathology given in the College of Veterinary Science, systematic autopsies of dead animals obtained from neighboring places, the clinics of the College, and the Animal Husbandry Department of the College of Agriculture, are being conducted throughout the year by the Department of Pathology and Bacteriology of the College of Veterinary Science.

Most of the autopsies are performed by the students themselves under close supervision of the professor in charge. The students are arranged in groups of three or four depending upon the size of the class. One student takes notes and the rest of the group are assigned to the different regions of the body. During the autopsy the students are requested to describe and diagnose in a brief manner the pathological changes found in each organ dissected out. A summary of the lesions is made at the termination of the necropsy and the cause of death is then determined.

Further work consists in making histological sections of tissues and bacteriological examination of secretions, fluids, blood, etc., whenever necessary, in order to verify the findings. Specimens for a pathological museum are collected from time to time and preserved following the Kaiserling process. The students are required to submit a well written protocol within two days after the necropsy. This is corrected and placed on file.

From January 1 to December 31, 1922, there were a total of 104 autopsies performed in the College of Veterinary Science. They were as follows:—Horses, 3; cattle, 12; carabaos, 6; swine, 17; dogs, 15; goats, 4; sheep, 1; fowls, 24; guinea pig, 19; rats, 3. Aside from these there were many autopsies of experimental nature of rats and guinea pigs which, for convenience and due to limited time, were reported under Laboratory Examinations.

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[1] Experiment contribution No. 214.

The following table shows the cause of death in the different animals on which autopsy was performed.

Diseases	Horses	Cattle	Carabaos	Dogs	Swine	Goats	Sheep	Guinea Pigs	Fowls	Rats	Total
Ascariasis (calf)	..	2	..	..	..	..	..	..	4	..	6
Acute gastro-enteritis (calf)	..	1	..	..	..	..	..	..	..	..	1
Acute sero-fibrinous peritonitis	..	1	..	..	..	..	..	..	..	..	1
Acute gastro-enteritis	..	..	..	1	..	..	..	..	..	..	1
Acute hemorrhagic gastritis	..	..	..	..	..	1	..	..	..	..	1
Arsenic poisoning	..	..	..	..	..	..	..	..	1	..	1
Acute hemorrhagic enteritis	..	..	..	..	..	..	..	..	2	..	2
Botulism	..	..	..	..	..	..	..	..	2	..	2
Congestion of the brain	..	1	..	..	..	..	..	..	..	..	1
Decomposition too advanced	..	..	..	..	..	..	1	..	1	..	2
Encephalitis	..	1	..	..	..	..	..	..	..	..	1
Filariasis (Dirofilaria immitis)	..	..	..	1	..	..	..	..	..	..	1
Fowl cholera	..	..	..	..	..	..	..	..	2	..	2
Fowl typhoid	..	..	..	..	..	..	..	..	2	..	2
Generalized epizootic lymphangitis	1	..	..	..	..	..	..	..	..	..	1
Gastro-enteritis (distemper)	..	..	..	1	..	..	..	..	..	..	1
Gastro-enteritis	..	..	..	..	..	..	2	..	..	..	2
Hemorrhagic septicæmia	..	..	..	..	3	..	..	..	..	..	3
Hemorrhagic gastro-enteritis	..	..	..	..	1	..	..	..	..	..	1
Hog cholera	..	..	..	..	3	..	..	..	..	..	3
Heat Stroke	..	..	..	..	1	..	..	..	..	..	1
Hemorrhagic cloacitis	..	..	..	..	..	..	..	..	1	..	1
Inanition	..	..	..	..	..	2	1	4	2	..	9
Intestinal impaction	..	..	..	..	..	..	..	2	..	..	2
Internal hemorrhage (ruptured auricle)	..	..	..	..	..	..	..	..	1	..	1
Kidney worm infestation	..	..	..	..	1	..	..	..	..	..	1
Pneumonia	1	3	..	..	6	1	..	..	1	2	14
Pyemia	..	..	..	..	..	..	..	..	1	..	1
Purulent peritonitis	..	..	..	..	..	..	..	..	1	..	1
Rinderpest	..	5	4	..	..	..	..	..	..	..	9
Sapremia	..	..	..	..	1	..	..	..	..	..	1
Septicæmia	..	..	..	1	..	..	..	..	2	..	3
Strychnine poisoning (experimental)	..	..	..	10	..	..	..	..	..	..	10
Scurvy	..	..	..	..	..	..	..	8	..	..	8
Sero-fibrinous peritonitis	..	..	..	..	..	..	..	1	..	..	1
Tæniasis	..	..	..	..	..	..	..	..	1	..	1
Toxemia	..	..	..	..	..	..	..	2	..	..	2
Traumatic injury	..	..	..	..	..	..	..	..	..	1	1
Uremia	1	..	..	..	..	..	..	..	..	..	1
											104

It may be noted from this table that pneumonia was the cause of death of a large variety and number of animals. The ten cases of strychnine poisoning in dogs were subjects used in an experiment. In September, rinderpest was introduced into the College herd, but, fortunately, due to its early discovery and the immediate institution of strict quarantine and sanitary measures, the epizootic was promptly checked. It will also be noted that many of the diseases here reported could have been cured with early and adequate treatment.

ABSTRACT

The nutritive value of the proteins of coconut meal, soy beans, rice bran and corn. H. H. Mitchell and Valente Villegas, *Department of Animal Husbandry, University of Illinois, Urbana, Illinois. Journal of Dairy Science* **6.** 1923.—The work was conducted to determine the value of the proteins of coconut meal, soy beans, and rice bran, and combinations of these with one another and with corn for maintenance and growth through metabolism studies with rats.

The losses of nitrogen on an N-free ration.—The losses of nitrogen in the urine during the first period of the experiment comprising seven days while the animals were receiving N-free ration was on the average 20.6 milligrams per 100 grams of body weight of the animal. The losses during the last period of the same duration when the rats were again put on an N-free ration was less than during the first period due probably to lessened vitality of the animals. The losses in the feces while the N-free ration was being given was also determined and is known as the "metabolic nitrogen" of the feces. The losses of this metabolic nitrogen during the first period was on the average 193 milligrams per 100 grams of food during the first period and 206 milligrams per 100 grams of food during the second period.

Results with low protein rations.—Rations containing 5 per cent of protein were tried. These included coconut meal, soy bean, and corn rations. The average utilization of the protein of coconut meal was 77 per cent, of corn 72 per cent, and of soy bean 78 per cent. Thus it may be concluded that there are no differences in nutritional value between the different classes of proteins found in corn, soy bean, and coconut meal when fed at a level of 5 per cent, but these differ in digestibility.

Results with medium protein rations.—Six rations were used in which the amount of protein in the feeds approximated 10 per cent. Besides the coconut meal, soy bean, and corn rations, combinations of these were used to determine any supplementary effect that the protein of one feed may have upon that of another. The average utilization coefficient found with the protein of coconut meal is 58, of soy bean 64, and of rice bran 67. According to these figures, it is evident that the proteins of coconut meal are less efficient for body requirements than the proteins of soy bean and rice bran, and that these two are almost equal in efficiency. In the combination rations the protein was derived from the constituent feeds in equal parts, the total amount being 10 per cent. The results of the experiment with these rations show that coconut meal and corn mixture has

a value of 58 per cent, showing no supplementary effect of any of the constituents of the feed. Soy bean and corn mixture gave a utilization coefficient of 66, thus indicating a slight supplementary effect of one feed upon another although the tests were too limited to warrant definite conclusion. Rice bran and coconut meal mixture gave an average value of 63 per cent or just the average of the value for coconut meal and rice bran. The results with the mixtures are in accordance with the other trials on vegetable proteins in which generally no marked supplementary effect of one protein upon another is shown. Supplementary effects have, however, been found when animal proteins are mixed with vegetable proteins.

The net protein values of feeds.—The average net protein content of some feeds have been determined as follows:

Feed.	*Content of net protein. per cent*
Corn	4.3
Rice bran	5.3
Soy beans	19.6
Coconut meal	11.1
Cottonseed meal	24.4
Alfalfa hay	6.6

Abstract by Valente Villegas.

COLLEGE AND ALUMNI NOTES

The Board of Regents and the Executive Committee of the University of the Philippines met at the College of Agriculture on October 27. An inspection of the College and the Experiment Station formed a part of the meeting.

Dean Maximo Kalaw of the College of Liberal Arts and member of the Executive Committee remained for a day or so as the guest of his sister, Mrs. Manuel Roxas, and went snipe hunting with Doctor Roxas and Moises Kalaw, who is a student in the College.

The Los Baños Biological Club, composed of members of the faculty of the Colleges of Agriculture and Veterinary Science and the School of Forestry interested in biological research, was organized November 15, 1923. Doctor B. M. Gonzalez, '13, of the Department of Animal Husbandry, is President of the Club, and Doctor L. B. Uichanco, '15, of the Department of Entomology, is secretary. Scientific programs will be arranged monthly, and brief papers will be read and discussed. The first meeting of the club, Los Baños Biological Club, was held on December 4, 1923, in the College of Agriculture Auditorium, when papers were read by Professor Dacanay, Doctor Tubangui, Doctor Fronda and Professor Herbert.

At the last meeting of the Ranchers' Club, the following members were elected to manage the affairs of the club this semester: Governor, Alejandro Catambay; Lieut. Governor, Eulogio Rodriguez, Jr.; Secretary, Mamerto E. Limuaco; Treasurer, Filomeno S. Mariano; Sheriff, Louis J. Dangilan; and Adviser, Doctor F. M. Fronda. The first anniversary of the club was celebrated with a live stock parade November 17, which was pronounced a decided success. A program, consisting of addresses by Dean Baker, Doctor Gonzalez, Doctor Fronda, and Profesor Elayda, Director of Extension Work, and musical selections by the College orchestra, formed the second feature of the celebration. The Ranchers' Club is a club of students who are majoring in Animal Husbandry.

Doctor José J. Mirasol, '15, Dean, Junior College, University of the Philippines at Cebu, was at the College recently for a short visit.

Professor Elayda, Director of Extension Service, went recently with Severo Capistrano, '15, to Paete, Laguna, for lanzon investigation.

Pablo N. Mabbun, B. S. A., '23, Assistant in Economics, was married to Miss Consolación B. Zarcilla of Rosales, Pangasinan, on November 18. The wedding was solemnized at Pasay, Manila. Mr. and Mrs. Mabbun have taken up residence in Anos, Los Baños.

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